

Handbooks of the Flora and Fauna of South Australia, issued by the
British Science Guild (South Australian Branch) and published by
favor of the Honorable the Premier (Sir Henry Barwell, K.C.M.G.).

THE MAMMALS OF SOUTH AUSTRALIA.

By FREDERIC WOOD JONES, D.Sc.

Part I.

CONTAINING

The Monotremes and the Carnivorous
Marsupials.

(The Ornithodelphia and the didactylous Didelphia.)

WITH ILLUSTRATIONS.

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EDITORIAL PREFACE.

Handbooks of the Flora and Fauna of South Australia, issued by the
British Science Guild (South Australian Branch).

Recognising the need for a wider diffusion of accurate knowledge of our Flora and Fauna, the Guild has undertaken the issue of a series of handbooks.

There is an admitted lack of inexpensive but accurate books dealing with the plants and animals of South Australia, and it is felt that the absence of such has been a real handicap to young Australia, and so to the progress of Australian science. These volumes, which have been planned to meet the want, are being prepared gratuitously by South Australian biologists and geologists: they will be printed and published by the State Government, and will be available for schools and the public generally.

INTRODUCTION.

To give a perfectly satisfactory definition of a Mammal is by no means an easy matter, but fortunately the general meaning of the term is so well understood that there is no need to labour the description of what may be considered as the essential characters which admit an animal to the zoological rank of the Mammalia.

Unfortunately there is no popular term which is a perfect substitute for the zoological designation of the Class. The word "bird" perfectly connotes the more scientific expression conveyed by the term "Aves." But neither "animal," nor "beast," nor "quadruped" can be considered as an adequate substitute for the term Mammal.

Without entering into details, the definition of which would be tedious, we may say that a Mammal is a backboneed animal which has warm blood, and which possesses some measure of hairy covering. That its chest and its abdomen are divided from each other internally by a muscular partition which is called the diaphragm; and that the great arterial trunk (the aorta), which arises from the heart, arches towards the left side of the body. Finally, to define the character which originally gave the name to the Class, the female is provided with cutaneous glands (mammary glands) which secrete milk for the nourishment of the young.

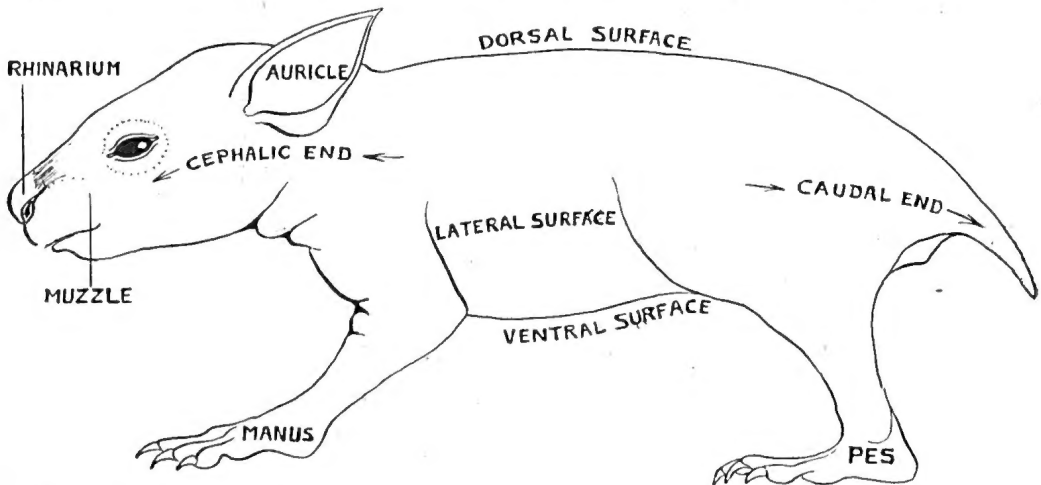


FIGURE 1.—Simple diagrammatic representation of a mammal to indicate the principal descriptive terms used to designate the larger parts and aspects of the body.

Since the purpose of the present volume is to furnish an elementary guide to the Mammals inhabiting South Australia, all unnecessary technical details will be excluded. But with the best wish in the world it is not possible to proceed any distance in the study of even the most ordinary Mammal without coming across certain things to which names must be assigned, and for which familiar names are lacking.

If we wish to give the proper name to any Mammal it is necessary to examine it systematically and to measure it. Only then can it be classified, and its identity finally settled. Certain features require special examination, since all parts of an animal are not of equal importance in the determination of its status. Here we will be almost entirely concerned with external characters, but it must be remembered

that these external characters are not in themselves sufficient to diagnose, beyond all doubt, the proper position of an animal in the scale of nature. Other, deeper, and more complex details must be considered. Nevertheless, external characters alone will lead a long way, and it is, therefore, worth while to pay some systematic attention to them.

In order to make the description of the external characters of any animal sufficiently accurate and sufficiently complete to enable the creature to be identified from its description alone, it is necessary to adopt some order in dealing with the different parts and appendages of the body. It is also necessary to use some special terms to distinguish parts and surfaces, and since all of these terms are not in ordinary every-day use, certain of them stand in need of definition.

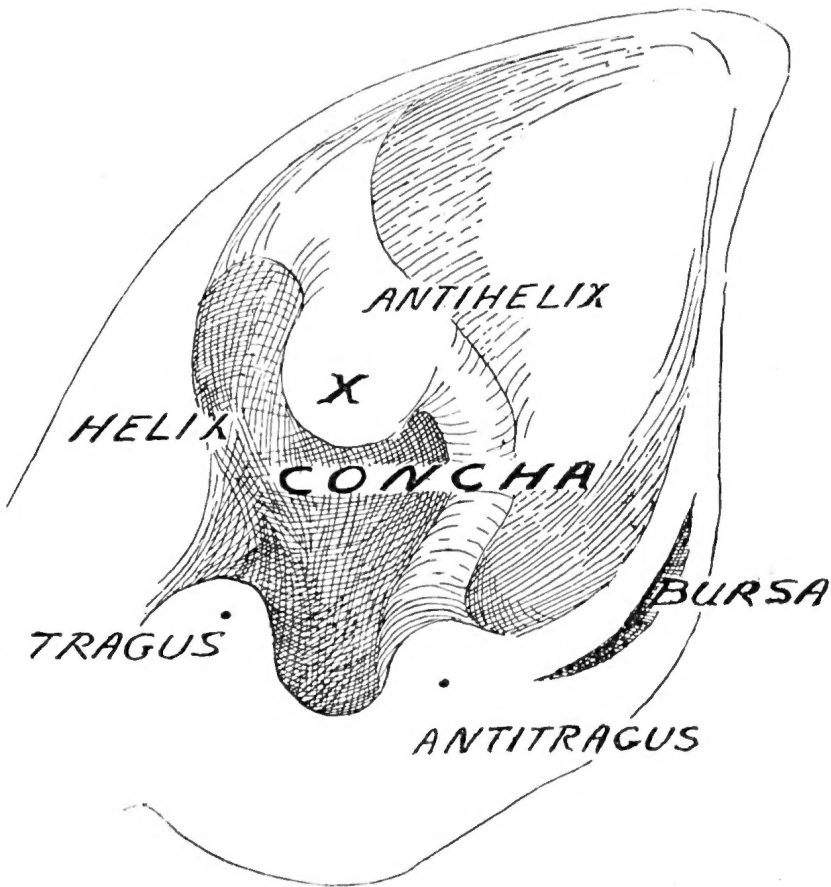


FIGURE 2.—Simple diagram of an external ear, or auricle. The process of the antihelix, marked X, is sometimes termed the *supratragus* or *metatragus*.

A diagrammatic mammal has been represented in Figure 1, and reference to that illustration will explain the terms most commonly applied to the larger subdivisions of the body. The word *muzzle* is best retained as the term for the hairy snout, or prolongation of the face which carries the mouth and the nose; while by *rhinarium* is meant only the actual opening of the nose, or the area in which the nostrils are situated. The mammalian rhinarium has very varying form, but it is usually covered by a specialised and hairless skin. The terms *manus* and *pes* are obviously better than hand and foot when applied to most mammals; and they are shorter and more accurate than the expressions fore-foot and hind-foot.

The external ear or *auricle* is an important feature among the distinguishing characters of an animal, and some of the terms employed to denote its parts need explanation. In the diagrammatic auricle represented in Figure 2, it will be noticed that the hollow portion or *concha* has a more or less definite rim or margin, which is most developed in front and behind at the points where the auricle joins the skin of the head. This outer rim is the *helix*. As variable processes developed from this rim are the *tragus* and *antitragus*, and in the hinder portion of the helix itself there is sometimes developed a curious little pocket called the *bursa*. Within the concha is another curled ridge, something like an inner margin to the auricle—this is the *antihelix*. From the antihelix there are developed certain processes in the same manner as the *tragus* and *antitragus* are developed from the *helix*. One of these processes is marked X in Figure 2. The terms used for these processes are rather confused in their use in zoological books. Sometimes they are called *supratragus*, sometimes *metatragus*, and sometimes *tragoid projections*—here they will be termed *processi antihelici*.

Most mammals have in different parts of their bodies certain specialised bristly hairs, which usually grow from little elevations of the skin. The bristles are termed *vibrissae*, and the little round bases from which they grow are known as *papillae*. The function of these structures is to furnish accessory organs of touch, for the long

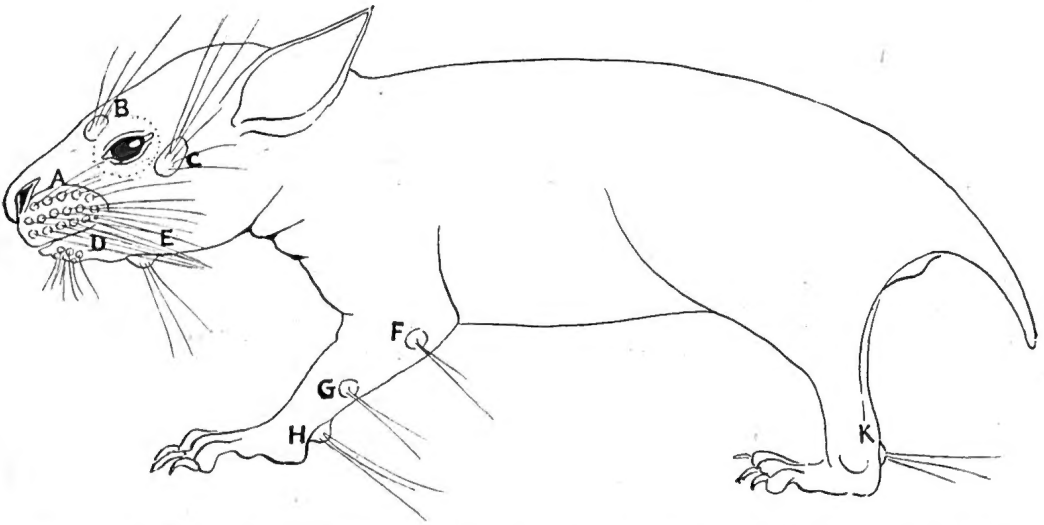


FIGURE 3.—Simple diagrammatic representation of a mammal to show the distribution of the sensory papillae and vibrissae. The groups are classified as follows:—A, mystacial; B, supra-orbital; C, genal; D, submental; E, interramal; F, anconcal; G, medial antebrachial; H, ulnar carpal; K, calcaneal.

sensitive hairs coming in contact with outside objects help the animal to guide itself about with safety. The most familiar vibrissae are the well known “whiskers” of animals, and the twitching of the sensitive whiskers of a creature such as a rat is familiar to everyone. The vibrissae forming the whiskers are known as the *mystacial* group. Other groups are indicated in Figure 3, and they consist of, a set above the eye, *supraorbital*; a set upon the cheek, *genal*; a set under the chin, *submental*; and a set between the two sides of the lower jaw, *interramal*. Upon the limbs are other sets of these bristle hairs. There may be as many as three

separate groups upon the fore limb, the *anconeal* near the elbow; the *medial antebrachial* about half-way down the forearm; and the very constant *ulnar carpal*, just above the wrist. Upon the hind limb there is only one set, and that, being situated upon the inner side of the ankle, is called the *calcaneal* group.

Of all the external appendages and parts of the animal's body the manus and pes are perhaps the most important as affording evidence on which to judge of the nature of the creature owning them. By a careful study of the manus and pes most of the mammals of Australia can be readily assigned to their proper group, and in many cases the actual identity of the animal can be absolutely established. In studying hands and feet note must be made in the first place of the number of *digits*. The typical mammalian number is five; but in many animals the number

has become reduced by the loss of certain digits from the manus or pes. Then, the relative length of the digits, as they radiate from the palm, differs in various animals. In what may be considered the typical condition, the 3rd or middle digit projects farthest, and the 2nd and 4th next farthest, the 5th being next, and the 1st being shortest of all. The arrangement of digits in order of their relative length may be expressed as a *digital formula*, and in the case we have considered, and illustrated at Figure 4, the formula would be written $3 > 2 = 4 > 5 > 1$: the sign $>$ standing for "longer than" and $=$ meaning "same length as."

At the ends of the digits there may, or may not be well developed pads or little cushions; these are termed *apical pads*, and they are marked from I. to V. in Figure 4. Upon the palm, which may be wholly or only partly naked, and may be covered by skin of very varying texture, are other cushions, one being situated typically at the base of the cleft between each pair of digits; these, numbered from 1 to 4, in Figure 4, are the *interdigital pads*.

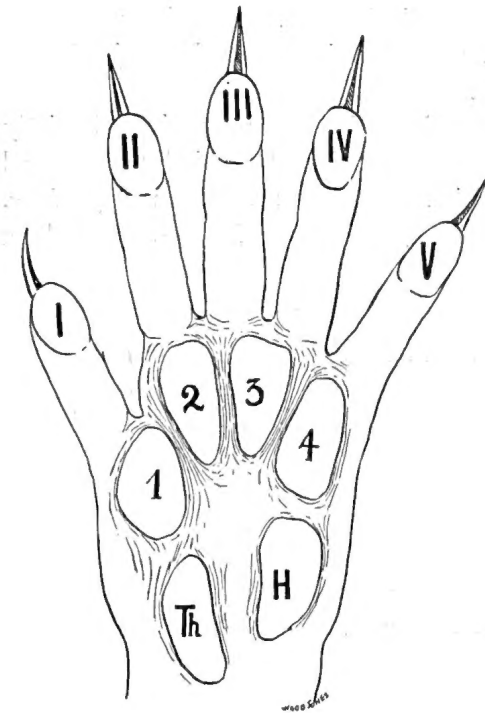


FIGURE 4.—Simple diagram to explain the naming of parts of the palm or sole. I., II., III., IV., V. mark the typical 5 digits. The figures being placed upon the 5 apical pads. 1, 2, 3, 4 denote the 4 typical interdigital pads and Th. and H. the thenar and hypothenar pads respectively.

In addition to these, there may also be a pad situated on the palm near the base of the first digit, the *thenar pad*; and another near the base of the fifth digit, the *hypothenar pad*. A typical mammal may therefore show five digits, and eleven pads, all constituted in a definite and characteristic fashion; or it may show a reduction in the number of its digits and pads; and all these things are to be noted in the description of the animal.

Although not so readily open to examination as the ears and feet, the teeth may still be reckoned among external characters, and the evidence provided by

an examination of the dental characters is always of the greatest importance, since teeth are so relatively indestructible that they may be all that is left of an animal long since extinct. It is possible that nothing more than the evidence afforded by the teeth may serve to link a living animal to its long extinct ancestor. To determine the number and the kind of teeth present is not a difficult task ; but the description of the form of the teeth and the details of all the little elevations or cusps on the surfaces of the back teeth is a business involving far too many technical terms to be attempted here. There are, roughly, three kinds of teeth in the mouth of a typical mammal—the cutters or *incisors* in front, the piercers or *canines* behind, and the grinders or cheek-teeth behind that. The cheek-teeth are again subdivided into two sets, the blunt grinding posterior *molars* and the sharper anterior *premolars*. The animal whose teeth are shown at Figure 5 has a

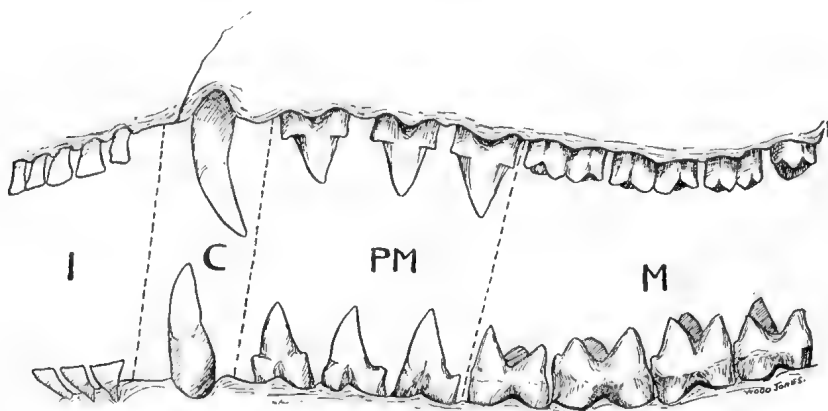


FIGURE 5.—The upper and lower teeth of the left side of the Short-nosed Bandicoot to show various kinds of teeth—I=incisors, C=canines, PM=premolars, M=molars.

very representative dentition which consists of 5 upper and 3 lower incisors on each side ; a single upper and a single lower canine on each side ; 3 upper premolars, 4 upper molars, and the same number of these teeth in the lower jaw upon the right and left sides of the mouth.

These facts may be incorporated in what is termed a *dental formula*, which is merely a numerical expression of the complete set of teeth present in the animal. In the case depicted in Figure 5 the formula would be as follows :— $1 \frac{5}{3} \cdot \frac{5}{3} \cdot C \frac{1}{1} \cdot PM \frac{3}{3} \cdot M \frac{4}{4}$, the actual animal illustrated being the Short-nosed Bandicoot (*Isodon obesulus*).

From time to time references will have to be made, in the ordinary course of distinguishing an animal, to certain characters of the skull. Cranial characters will be omitted wherever possible, but in some instances their importance is so great that they cannot be passed over completely. In most cases a figure of the skull will be considered sufficient, but at times this will have to be amplified in the text, and therefore it is necessary to call attention to certain technical terms, and some unfamiliar names for bones. In order to make these names clearer Figures 6, 7, and 8 have been inserted. The drawings have been made from the skull of the so-called Tasmanian Wolf (*Thylacinus cynocephalus*), for although it is not at the present day a living inhabitant of South Australia, it lived here in comparatively recent times. In most text books of Zoology the bones of the skull are illustrated

by reference to figures of the cranium of the domestic dog. The dog's skull is the type usually chosen for systematic study. The skull of *Thylacinus* is in its general rough outlines so like that of a dog that the reader who cares to proceed further

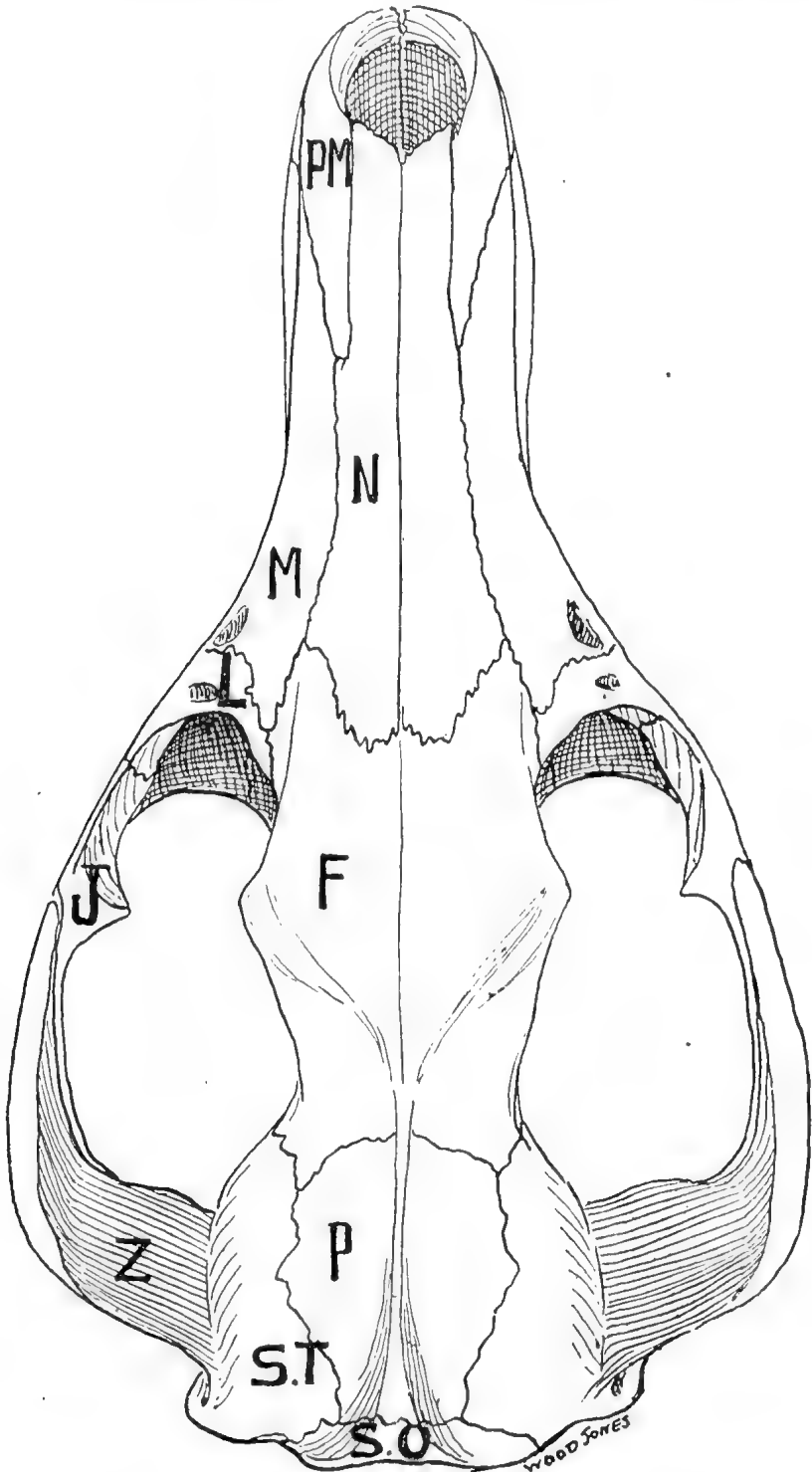


FIGURE 6.—Dorsal view of the skull of *Thylacinus* to show the principal bones entering into its formation. PM=premaxilla, M=maxilla, N=nasal, L=lachrymal, F=frontal, J=jugal, Z=zygomatic, P=parietal, ST=squamous temporal, SO=supraoccipital.

will derive a good insight into some of the most curious mammalian problems by noting not only the generalised likeness, but the specialised total unlikeness of the

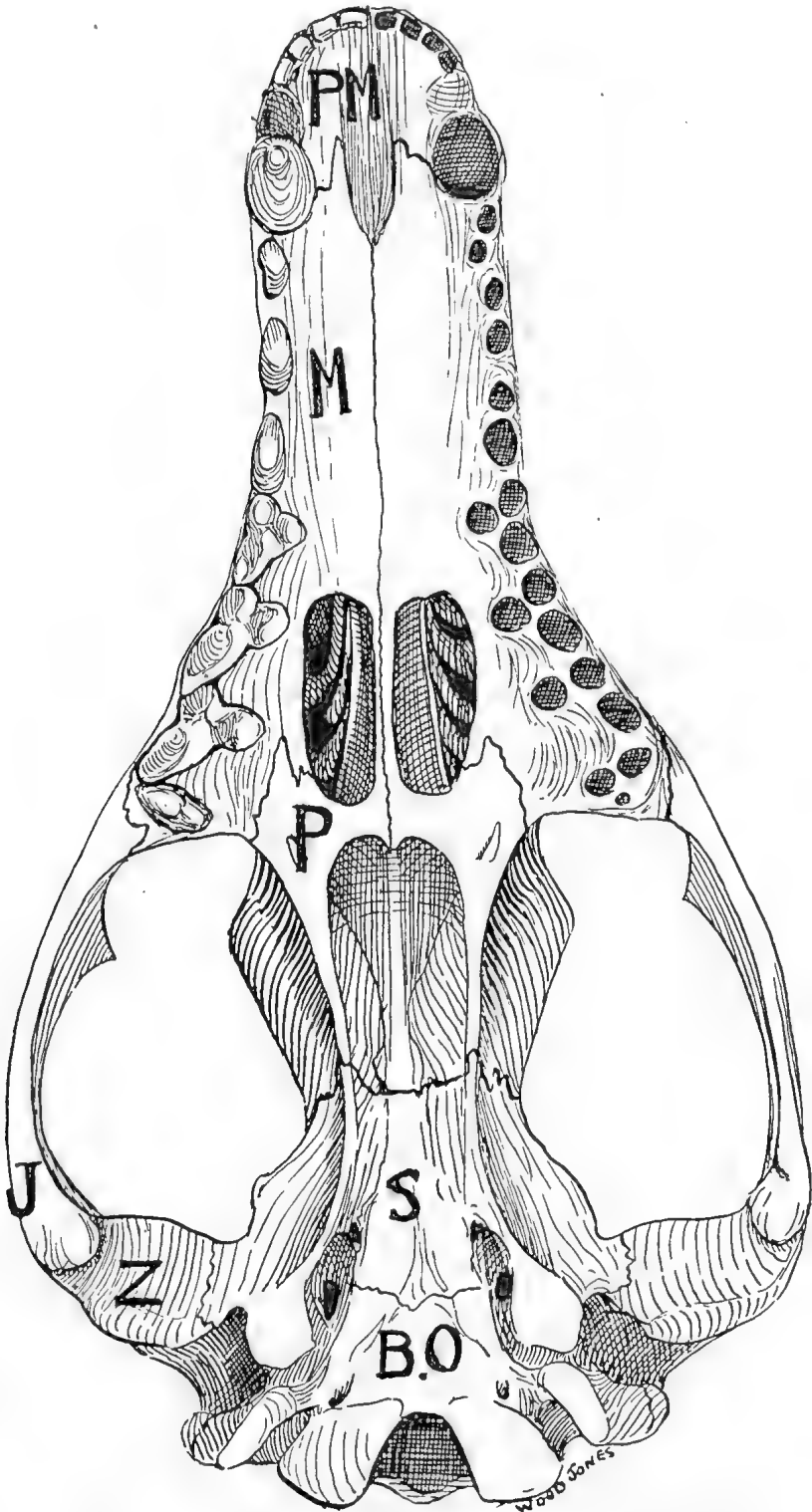


FIGURE 7.—Ventral view of the skull of *Thylacinus*. PM=premaxilla, M=maxilla, P=palate, J=jugal, Z=zygomatic, S=sphenoid, BO=basioccipital.

The teeth have been removed on the right hand side of the figure in order to show the sockets for their roots.

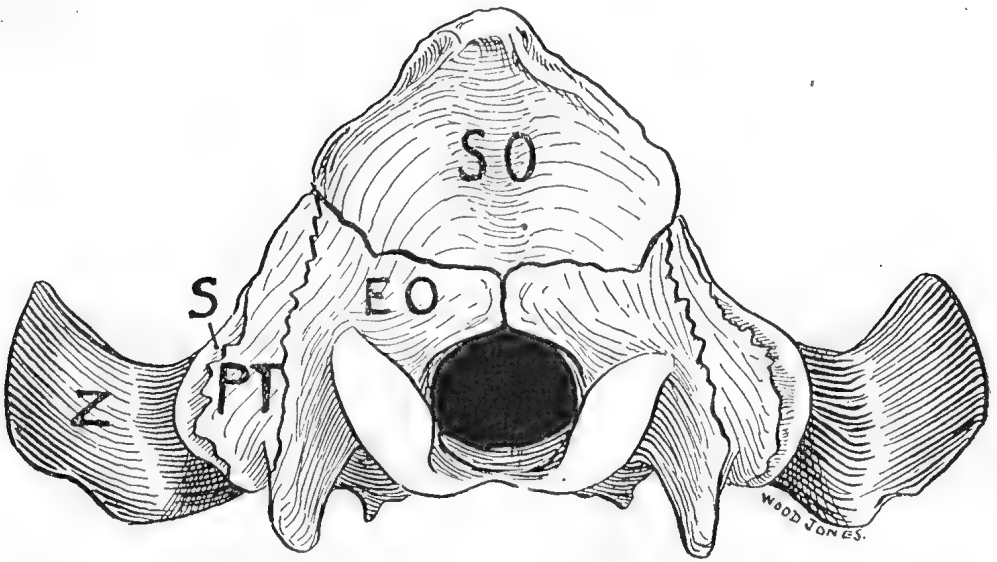


FIGURE 8.—Caudal view of the skull of *Thylacinus*. SO=supraoccipital, PT=petrous temporal, S=squamous temporal, Z=zygomatic, EO=exoccipital.

two types. The illustrations are intended to be a guide to enable the reader to distinguish the main parts of the skull, and descriptions of individual bones will not be given until the occasion arises.



FIGURE 9.—Diagram to illustrate the correct method of measuring the length of the tail and of the pes.

In addition to the examination of the various parts of the body, it is necessary to take a series of accurate measurements of the animal in order to settle the question of its identity. To be of any real use these measurements must be made in a constant and definite manner. All measurements are, of course, recorded in the metric system. First, the total length of the head and body should be recorded by measuring from the tip of the snout to the base of the tail, along the curve of the back. This measurement should be taken with a tape, and the animal should be straightened out as much as possible without being unnaturally stretched. Next, the length of the tail should be taken in the way shown in Figure 9. The terminal tuft of hair on the tail should not be included in the measurement. The ear should be measured from the notch at its base to

the most distant point of its tip, the method of taking the measurement being shown in Figure 10. The hind foot should be measured from the part which represents the point of the heel to the tip of the most distant toe, but the

claw must not be included in the measurement. There are several other less important measurements of the body, and parts of the body, but these need no special directions for their recording and they will be defined as they arise.

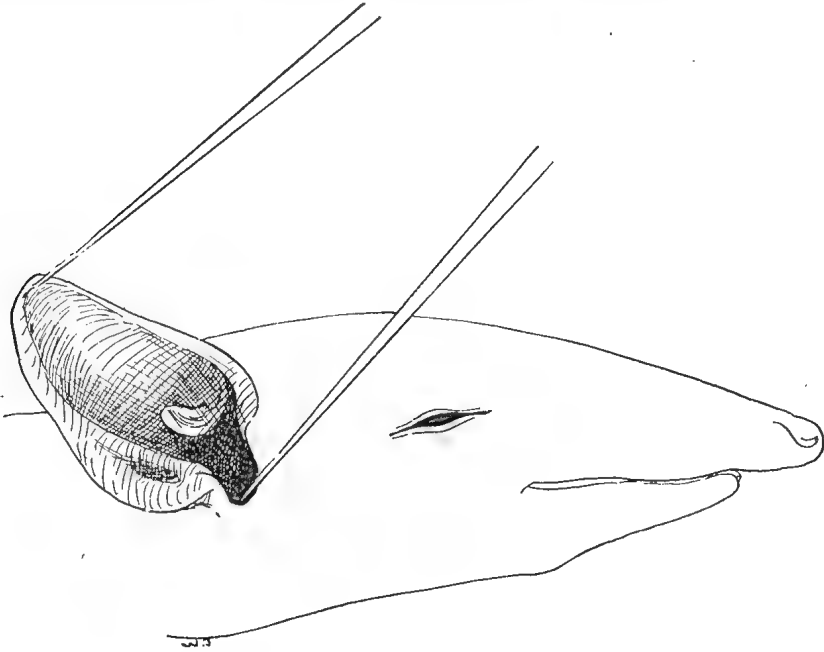


FIGURE 10.—Diagram to illustrate the correct method of measuring the length of the external ear.

All measurements recorded in these pages are made upon recently dead or spirit preserved animals, except where otherwise stated.

CLASSIFICATION OF THE MAMMALS.

An assemblage of animal forms so large as the Class Mammalia embraces types which differ from each other by structural alterations which are, at times, very considerable. For this reason it becomes necessary to split up the main Class into smaller Sub-classes, each Sub-class containing a certain number of forms which are obviously united to each other by a natural common structural bond, but which differ by the possession of some structural feature from members of the other Sub-classes. Some definite scheme of classification must be employed in order to reduce the study of the Mammals to the position of an ordered branch of knowledge.

Many schemes for the classification of the Mammals have been proposed, and here we will adopt one of the oldest, and certainly the simplest, of the systems that have been put forward since the knowledge of the Mammals was sufficiently precise to warrant the drawing up of such classifications. So long ago as 1816, M. de Blainville pointed out that all Mammals fell into three distinct groups, when the characters of the reproductive system of the female were taken as the criteria on which to estimate their rank. In the one group the internal genital system of the female presented certain general resemblances to the condition seen in birds. This group he, therefore, termed *Ornithodelphes*. In the second group the internal genital system of the female was essentially double, the right and left halves remaining separate. For this reason he termed his second group *Didelphes*. In the third group the two bilateral halves of the female internal genitalia are united into a single middle-line structure; and since the system was essentially single, he named this group *Monodelphes*.

These three terms, altered by Greek terminations into *Ornithodelphia*, *Didelphia*, and *Monodelphia*, although widely employed formerly, have, to a great extent, passed from modern scientific usage. The reason for their present disuse is that they have been replaced by the symbols stereotyped by Huxley in 1880 for the three basal Mammalian groups. Huxley employed two terms previously used in 1872 by Gill, and added a third; but he somewhat altered the connotations of the terms. Gill had introduced the word *Eutheria* and had adopted from Lamarck (1809) his term *Prototheria*: Huxley then added a third, *Metatheria*, and employed them to represent the three basal groups, of which de Blainville had labelled the actual members with his three simple terms. Thus the term *Eutheria*, as used by Huxley and by most modern naturalists, is practically the equivalent for *Monodelphia*, the term *Metatheria* for *Didelphia*, and the term *Prototheria* for *Ornithodelphia*.

There is a modern tendency to return to the two primary groups as pictured by Gill, and this is effected by uniting the *Metatheria* and the *Eutheria* as subdivisions of a single group termed *Theria*.

In the present volume the original three Sub-classes will be retained, and the original names used by de Blainville to distinguish them will be employed. Some explanation for this apparently retrograde step must be given. Huxley's scheme has the advantage of being easily capable of extension to extinct or to hypothetical creatures, of which the structure of the internal genitalia cannot be known; but

it has the great disadvantage of implying an inter-relationship between the three groups, which, although assumed by Huxley, is now well known not to represent the affinities, or the evolutionary sequence of the groups. On the other hand, the terms used by de Blainville are simple, and they imply no more than we are actually certain of; their aptitude may be readily demonstrated by the ordinary methods employed in the study of anatomy; they can be tested and understood by anyone.

That the Didelphia and Monodelphia are here kept as separate Sub-classes, and are not united into the single group Theria, is defended on the grounds that the anatomical differences between the two groups are great enough to justify the separation. An anatomical distinction need not be very striking in its manifestation in order to rank as a great distinction, but it may involve some item of body-building so fundamental that its real significance outweighs its apparent minor character. The anatomical differences between the Didelphia and the Monodelphia are of this fundamental nature. For the purposes of the present volume it will be enough to say that, whereas in the Didelphia the ducts of the kidneys (ureters) run between the female genital ducts (oviducts), in the Monodelphia the oviducts run between the two ureters. It is this alteration of what may be termed ground-plan anatomy which accounts for, and creates, the striking differences between the reproductive systems in the two Sub-classes.

There are other terms which are employed to denote the separate Sub-classes, but these names are best relegated to subordinate rank. The terms "higher mammals" or "placentals" are not satisfactory substitutes for Monodelphia: "marsupial" or "pouched animals" are not true synonyms for Didelphia; and the term Monotreme is best employed, not as a substitute for Ornithodelphia, but as the name for the Order in which the living Ornithodelphians are placed.

The distinguishing features of the three Sub-classes will be dealt with more fully when the actual members of the Sub-classes are considered; but meanwhile it is well to separate the Sub-classes using only a minimum of features, and employing only a minimum of technical terms.

SUB-CLASS I.—ORNITHODELPHIA.

(MONOTREMATA, OR PROTOTHERIA.) See Figure 11.

The genital ducts of the female (oviducts) are simple, and are entirely separate from each other in the whole of their length. They open into a chamber, which is common to them and to the outlet of the urinary system, and is termed the *Uro-genital Sinus*; this uro-genital sinus opens into another chamber into which the outlet of the intestinal canal also opens. The final chamber is known as the *Cloaca*, and it opens to the exterior by a single opening which is under muscular control. In the male the genital ducts (vasa deferentia) also open into the *Cloaca*, and not into a urethral canal such as is found in other mammals.

The mammary glands are diffuse, and the secretion which is made in them exudes from multiple apertures on the skin of the abdomen, there being no nipple to provide a discrete opening for the ducts.

The young are produced from thin-shelled eggs. A temporary pouch, or *Incubatorium*, is developed in some forms for the reception of the egg and for the protection of the newly-hatched young.

EXAMPLES.—The Native Porcupine (*Echidna*) and the Platypus (*Ornithorhynchus*).

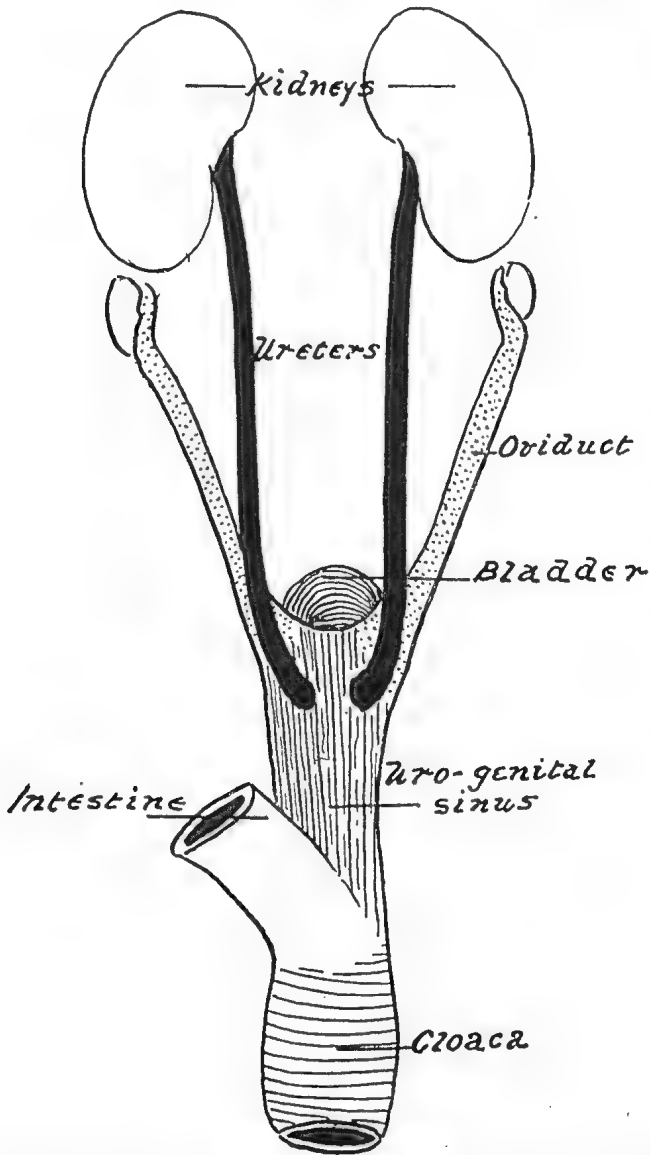


FIGURE 11.—Simple diagram of the female reproductive system as it is present in the *Ornithodelphia*. The parts are viewed from the dorsal surface.

SUB-CLASS II.—DIDELPHIA.

(MARSUPIALIA, or METATHERIA.) See Figure 12.

The genital ducts of the female are specialised, there being a well-marked uterine portion. The uterine portions of the two sides, however, remain entirely separate, and do not unite in the middle line to form a single median uterus. The separated uterine portions of the oviducts join separated lateral vaginae, and the lateral

vaginae open into a uro-genital sinus common to them and to the outlet of the bladder. The uro-genital sinus opens to the exterior by an orifice, which, although separate from that of the intestinal canal, is encircled, with that orifice, by a common ring.

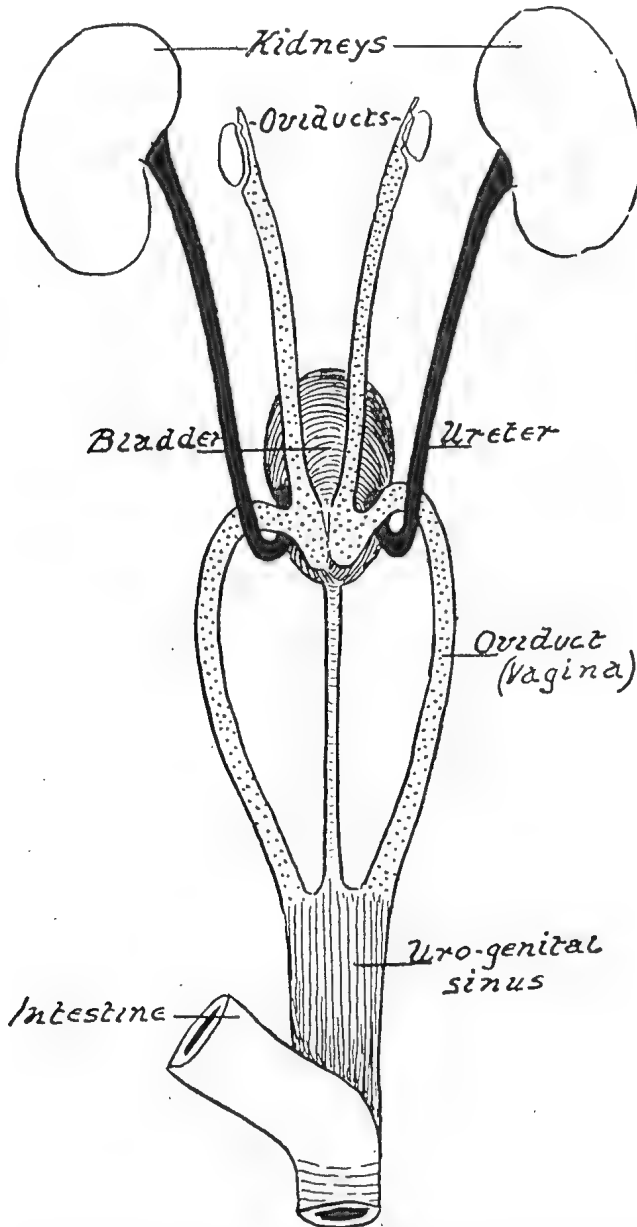


FIGURE 12.—Simple diagram of the female reproductive system as it is present in the *Didelphia*. The parts are viewed from the dorsal surface.

The cloaca, which is a deep chamber in the Ornithodelphia, is represented in the Didelphia by a depression of varying degrees of shallowness, but which in all conditions has an individual muscular mouth.

The ducts of the kidneys (ureters) pass between the genital ducts. The genital ducts in the male open into a complete urethral canal as they do in the Monodelphia. The mammary glands are provided with particularly well-developed nipples, and

they are typically situated within a skin fold on the surface of the abdomen which is known as the pouch, or *Marsupium*. The young are born alive, after a short period of utero-gestation, and they are born in an immature condition. For a variable period their post-natal life is spent clinging tightly to a nipple within the marsupium.

EXAMPLES.—Kangaroos and Wallabies, Native Cats, Opossums, Bandicoots, and all the rest of the native or pouched animals.

SUB-CLASS III.—MONODELPHIA.

(PLACENTALIA, EUTHERIA, or HIGHER MAMMALS.) See Figure 13.

The genital ducts of the female are specialised, there being well-marked uterine portions, which typically unite to form a single median uterus. The uterus opens

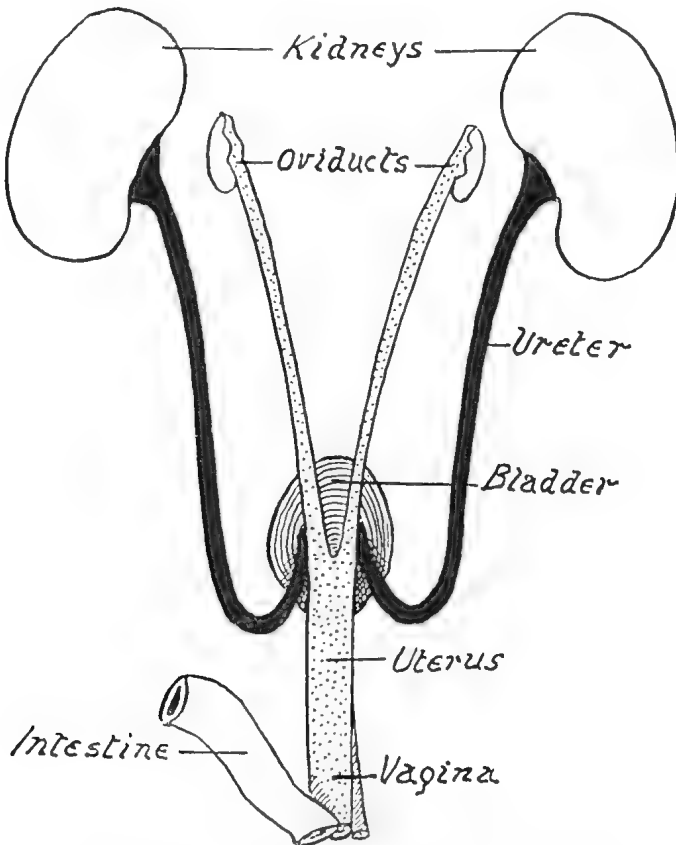


FIGURE 13.—Simple diagram of the female reproductive system as it is present in the *Monodelphia*. The parts are viewed from the dorsal surface.

to the exterior by way of a single median vagina. The ducts of the kidneys (ureters) pass on each side of the genital ducts. The genital ducts of the male open into a complete urethral passage. The mammary glands are discrete: they are provided with nipples, and they are situated on the ventral surface of the body at varying

points along two lines (mammary lines) which stretch from the front of each arm-pit to the root of the tail. The young are born alive after a varying, but more or less prolonged period of utero-gestation, in a condition of considerable, but widely varying, maturity.

The young obtain their nourishment at intervals from the maternal mammary glands, but they are not retained suspended from the nipple, nor sheltered within a skin-fold of the maternal ventral surface.

EXAMPLES.—Rabbits, Rats and Mice, Cats, Cattle and Sheep, and all the rest of the non-pouched animals.

Of the three Sub-classes, the Ornithodelphia comprises the most lowly Mammals, which display in their structure and functions the greatest resemblances to the lower vertebrates. These animals are confined to Australasia. The Didelphia are, in many features, considerably less developed than the Monodelphia, and they are at the present time confined to Australasia and to the southern portion of America. The Monodelphia, the most perfect expressions of mammalian development, may be said to have overrun the whole Earth.

SPECIAL PROBLEMS CONNECTED WITH THE MAMMALIAN FAUNA OF AUSTRALIA.

There is no other mammalian land fauna around which problems centre with such crowded possibilities for speculation ; no other land, the mammalian colonists of which afford a like interest both in the manner of their advent, and in the fashion of their forms. For the zoologist, the palaeontologist, and the physiographer, the study of the Australian Mammals presents a field of research of the utmost interest and importance.

The Australian continent is known to have had a long period of geographical separation from the other large land masses of the globe. It is known that its separation occurred after the Didelphian Mammals had had their opportunity to populate it by coming in from the adjoining land masses ; and that it occurred before the Monodelphian Mammals had opportunity to follow them by any considerable land bridges.

There are various portions of the Earth's surface which may be described as "dead ends," as outliers of land areas which have become, more or less completely cut off from the rest of the world. Into these dead ends a fauna may be driven, as fugitives before some advancing danger ; and from these dead ends it may be that the fugitives have no outlet. At one period Australia constituted such a dead end ; but, after it had received its population of Ornithodelphians and Didelphians, it became cut off from adjoining land masses ; and to-day it constitutes the great example of an isolated dead end, a faunal asylum completely severed from all the rest of the world. It is a place into which a definite phase of the developing animal series has penetrated, and become imprisoned ; and thus has been preserved undisturbed by subsequent developments in the animal kingdom.

Herein lies the great interest of the study of Nature in Australia, for Australia constitutes the great natural reserve for the world's archaic forms, and every Australian should regard himself as a custodian who is responsible for the conservation of these creatures. Exactly when and where the Australian mammalian fauna came into existence does not greatly concern us ; we know at any rate that it did not originate in Australia. During Mesozoic times the Didelphia flourished in Europe and in North America. In Europe they became extinct in the Tertiary period ; and in America they were driven South, on the road to the dead end of South America, where they linger to the present day. Probably begot in the connected northern land masses, they were driven by the better endowed Monodelphians into the dead ends of the earth. The Monodelphians, with superior intelligence and better equipment, pushed them in front, and drove them by successive waves down the great American continent, until now they have a rather slender footing in the southern portions of the New World. The same pressure probably drove them across Asia, and thence to the land bridge now represented by the islands to the South and East of the Malayan chain. By the same process of the perpetual stress of competition with the superior Monodelphians, they were driven into Australia, which, at the time of their advent, was connected with other landmasses of the globe.

By what actual route did the Didelphians reach Australia? It is possible that Australia was then connected, in the region of Torres Straits, with a land bridge now represented by the Malayan chain of islands. It is also possible that Australia was connected with a southern continent of Antarctica and so with South America. Did the Marsupials, driven into the dead ends, come in by a northern connection, or did they come in by the south? There are advocates who plead with much cogency, and with a great weight of authority, for each of these views. Tasmania has its Ornithodelphians and its Didelphians, and possesses, as living forms, some outstanding species which are unrepresented among the existing fauna of the mainland of Australia. It possesses also, as fossil remains, an extremely primitive creature named *Wynyardia*, which seems to have been a possible ancestor of several of the modern types of Australian marsupials. It is permissible to argue that, since Tasmania has a comparatively rich marsupial fauna, and as the marsupials become successively poorer in genera as we pass northwards in Australia, the route of immigration was from the South. We may postulate that the marsupials, driven into South America, invaded Antarctica, or some other lost land mass between South America and Australia; that from here they invaded Tasmania, and thence, by an undoubted land bridge, peopled Australia and spread northwards to the southern islands of the Malayan chain. Many people believe that such has been the actual progress of the marsupials.

But there is an alternative view. We may assume that the animals were driven along two divergent routes, on the one hand into the dead end of tropical America, and on the other along the land connections of the Malayan chain. And from the Malayan chain they came by land bridges into Australia, and finally into Tasmania. This view is the one adopted here.

If we take certain archaic animals which belong to the Monodelphia, we can follow their dispersal more easily than we can that of the isolated Didelphia. One of the most primitive forms of the hoofed animals (Ungulates) is the Tapir. The history of the Tapirs seems to be clear enough. They were driven from a northern centre of dispersal down into Central America, where they exist to-day as *Tapirus* (*Elasmognathus*) *bairdi*, and *T. dowi*. They went further South, and entered South America where they are represented by the living forms *T. terrestris* and *T. roulini*. By a divergent route the stock was also driven to the Malayan chain—Malay Peninsula, Sumatra, Java, and Borneo—where its modern descendents are known under the name of *T. indicus*. The living Tapirs are therefore confined to the Southern portion of the great American continent, and to the Malayan chain; but their northern origin seems clear. The ancestral form is found in France and in Germany, in deposits as old as the Miocene, and in the Red Crag of Suffolk in England, and this ancestral form is represented by such types as *T. priscus* and *T. arvernensis*. The Tapirs never reached Australia, no available land bridge being in existence at the time of their arrival at the threshold of the Australian continent.

The same facts are again demonstrated by the present distribution of the Edentates, a lowly Order of the Monodelphia. In South America there are the Sloths and Armadillos; in South Africa the Aard Varks; and in the Malayan chain the Pangolins. All are primitive creatures. All have presumably been driven into the dead ends of the Earth; but driven into them after Australia was isolated.

Moreover, this same story is unfolded when we inquire into the distribution and dispersal of a host of other land creatures.

The view that the marsupials were driven into Australia, and thence into Tasmania, by land bridges existing to the North is, therefore, supported here. But to uphold such a thesis is not to deny the former southern connections of the Australian continent. The argument that the Marsupial population is richer and more diversified in the South, we would meet by saying that this is the expectation if the fauna were driven in from the North. We know that the Celtic race was driven westwards in the British Islands by invaders from the East; and the fact that we find the Celts more pure and more dense on the western confines of Britain does not lead us to suppose that the West was their point of entry. The scattered Marsupials of the Malayan chain we would regard, not as the farthest driven outliers of the Australasian marsupials, but as the locally settled members of a migrating race. The denser population of marsupials of southern Australia and Tasmania we regard not as the immediate immigrants, but as the pioneers advanced towards the farthest confines of their territory. Granted that the marsupials were driven in by pressure of the Monodelphia, and by way of land bridges from Malaysia into Australia, it is necessary to postulate that, after the entry of the marsupials, these land bridges were severed, and the isolation of Australia was complete, else would a hord of monodelphian Mammals have entered in their wake. But though the land bridges, which connected Australia with the northern land masses, were broken after the advent of the marsupials, nevertheless, certain animals, representative of the Monodelphia, managed to find their way into the isolated continent.

The first class of the Monodelphian immigrants—the marine animals, such as the seals and whales—offers no outstanding problem. The sea was theirs to traverse as they pleased; and they came to the shores of Australia, as to the shores of other lands, as mariners. As Cook and Flinders came to Australia, so did the seals and whales, by ocean highroads.

The second group—the bats—likewise offers no problem. Theirs was the realm of the air, and they cared not for land bridges. As bats have peopled the islands of the Pacific so they have peopled Australia. They have taken up their abode here and have become modified, and have given rise to a definite type of Australian Chiropteran fauna. Their colonization is evidently an old standing achievement.

In the third group come the Rodents—the rats and mice. These were early immigrants, but their dispersal is probably due to precarious means; they also do not need a land bridge in order to people distant lands. We know that oceanic islands receive their rat population by floating islands, by floating logs, and by flotsam and jetsam of all sorts. It is not necessary to postulate a land bridge in order to supply an isolated land area with rats and mice. Christmas Island in the Indian Ocean may be taken as an example. Though a true oceanic island without any former land connections, and situated over five hundred miles from the nearest land, this island received its murine fauna sufficiently long ago to permit of the local development of two outstanding types of rats, specifically different from all the rest of the rats and mice known from other parts of the world. We know that the introduction of rats and mice into Australia must have been very early, for the bones and teeth of several species are found in cave deposits all over Australia, associated with the bones of marsupials which have since become extinct. We

may also assume that the murine Rodents are old inhabitants of Australia, because of the great specialisation which is displayed by many Australian species. The Australian Water rat (*Hydromys*) is a very remarkable animal, which is essentially an Australian specialisation; and many of the rats from the more arid regions of the centre are typical products of the country, and have evidently been long established. Almost certainly they came to Australia without the help of land connections, otherwise the monodelphian Insectivora and Carnivora would have accompanied them.

Despite the speculations that have for many years been rife concerning the status of the Dingo, this animal is probably surrounded by a romance altogether different from that attaching to the Water rat. The special characters of the Dingo will be dealt with in their proper place, and here we may dismiss it as being the black-fellow's travelling companion—the dog that came, certainly in the remote past, in company with his master the Australian aboriginal.

Long after the aboriginal came with his dog, the white man tried his hand at introducing his domesticated animals, and some that were not domesticated. As in so many other cases, man has meddled with Nature with disastrous results. In the isolated Australian continent the Ornithodelphia and Didelphia existed untouched by the competition of the better equipped Monodelphians; they lived safe from the superior craft of any carnivorous member of the higher Mammalia. The black man and his dog were their first formidable enemies, and probably the fate of the largest and most peculiar of the Marsupials was sealed by the advent of the aboriginal and the dingo. Yet what the aboriginal and the dingo have accomplished in the way of extermination is as nothing compared with the more modern havoc wrought by the white man with his firearms, his traps, and his poison; by his dogs and cats, and by his most destructive introduction, the fox.

Apart altogether from the interest of the Australian Mammals as immigrants to their isolated home, apart too from their intense importance as an archaic and a dying fauna, there is the valuable light which their study is capable of throwing on certain general biological problems. The peculiar Australian Mammals provide the student with one of the grandest and most instructive examples of the phenomenon known under the name of *Convergence*. In order to appreciate this very fundamental and important biological principle, it is best to take a purely imaginary case and study it in a perfectly abstract way, remembering always that the hypothetical can readily be replaced by the actual, when appeal is made to the facts of palaeontology and zoology; and that the abstract study can always be made concrete when knowledge and opportunity afford materials for research. Suppose some animal stock to become domiciled in a particular geographical area, which presents a particular type of environment suitable to the wellbeing of the stock. The stock will multiply, and with the increase in the number of individuals, there will be a tendency to spread from the original centre of domicile. As the individuals range further afield, it is likely that they will come to invade new areas which present, in some degree or other, environments differing from that of the original centre of domicile. From a desert region, for instance, they may invade forests, or from forests they may invade mountains or plains. In their radiation they may encounter all those different environmental stations which the physiography, and the climate, of the land masses of the world afford.

Now it is generally recognised that the forms of life typical of any specialised environment are modified in harmony with the demands of the environment. We recognise a typical desert fauna, and we know that, broadly speaking, living things have to become adapted, by some means or other, to their environment, or else they will cease to exist. It will be seen, therefore, that in the imaginary case we have been considering, the stock, which is radiating from a centre of domicile into areas affording differing environmental conditions, will tend to become adapted to the different environments, by a series of changes in habit and form, each change being in harmony with the peculiar circumstances in which the radiating stock happens to find itself.

The actual effect that will be produced in this way is that the radiating descendants of the original stock may become differentiated into a series of modified forms, each form adapted to its new station ; the number and distinctness of the new forms being dependent on the variety and the distinctness of the new environments. The hypothetical original stock may be an arboreal one inhabiting a forest region, some of its radiating members may come to dwell on plains and adopt a cursorial life, and become structurally impressed with its accompanying physical adaptations. Some may encounter lakes or rivers, and become modified for an aquatic life ; some may burrow underground, and become adapted to fossorial habits. Some may take to the air and become volant ; some to leaping and become saltatory, as opportunity and circumstance demand. Again, as the radiating stock encounters new environmental conditions, its opportunities for obtaining food may vary ; some members may become domiciled on grassy plains, and become herbivorous, grazing animals ; some may inhabit bush country, and adopt a browsing method of obtaining vegetable food ; and some may find insects, or other animals, more suited to their new physiological demands, and so become insectivorous or carnivorous. In any case the change in the method of obtaining food will lead to changes in the type of the creature, and the adaptations will be in harmony with the demands of the environment.

We may say, therefore, that a stock will become progressively altered by adaptations to its environment as it radiates from its centre of domicile, and this, in brief, is a statement of the Law of Adaptive Radiation. Let us now take the concrete case of the marsupial fauna of Australia. We have seen that the original stock came to Australia, by some route or other, as colonists from the other land masses of the globe. Arrived in Australia, they found a land presenting almost every conceivable type of environment. There were trees up which they could climb and lead arboreal lives. The Australian Phalangery commonly, but wrongly, known as Opossums, are typical examples of arboreal animals. They could over-specialise as tree climbers and become, in the end, condemned to a life spent clinging to branches ; and of this over-specialisation the Koala (*Phascolarctus cinereus*) is a notorious instance. There were open plains over which they could run and become cursorial, and although no marsupial has become a definite hoofed animal, nevertheless the Pig-footed Bandicoot (*Choeropus castanotis*) shows certain structural modifications along the lines that have led to the development of typical hoofs in other running stocks. The bulk of the marsupials which came to inhabit open country took to leaping and becoming saltatory animals, and no better examples of saltatory modifications could be found than those seen in the kangaroos and wallabies.

Again, in certain situations, an aptitude for burrowing may prove of the utmost importance to an animal, and the Bandicoots are good examples of animals which burrow both in search of food and of shelter.

The habit of burrowing may easily lead to such profound modifications of structure that the animal becomes unfitted for any life save that spent delving in the soil. The animal known as the Marsupial Mole (*Notoryctes typhlops*) has taken to this mode of life, and become a most completely specialised fossorial animal. Water, in the form of rivers, creeks, and lagoons, was present in Australia for the marsupials to take possession of, but it is a strange thing that no Australian marsupial has taken to an aquatic, or even a semi-aquatic life; no Australian Didelphian has become modified for life in the water. It might be thought that a pouched animal was debarred from living in the water by the mere fact of its possessing a pouch; but in South America a true Opossum (*Chironectes*) has made a conquest of the water. The Ornithodelphian Platypus and the Monodelphian Water rat are Australia's own aquatic animals.

But, whilst all these different surroundings and opportunities were open to the marsupial stock confined in Australia, it must not be forgotten that a similar series of varied environments was available to the Monodelphia present in the other land masses of the globe. The Monodelphia could radiate and become adapted, and their adaptations naturally followed the same lines as those that we have been picturing among the Didelphia. It therefore happens that, taking the Didelphian series on the one hand and the Monodelphian series on the other, it is possible that similar environments having demanded similar adaptations, certain members of the one stock might well have come to resemble, in rough general likeness, some members of the other.

A fossorial marsupial, for instance, might come to resemble in certain adaptive features, a fossorial member of the Monodelphia; and it is possible to imagine that, with a high degree of specialisation, the general resemblance might come to be very exact. The production of such likenesses between members of different stocks constitutes the phenomenon known as Convergence. As illustrations of this phenomenon we may give the following instances. In Africa, in Asia, and in South America are certain Rodents which have become protected from their enemies by the production of an armour of spines or quills. In general gross external details these animals—the true Porcupines—are so like the Ornithodelphian *Echidna* that this Australian animal, when first made known to science, was ranked near to them in the zoological scale; and even now, although its zoological position is quite well established, the animal is still known in South Australia as the Porcupine, or the Porcupine Ant-eater, or the Native Porcupine.

A similar convergent adaptation is seen in the great Monodelphian group of the Insectivora, and the Hedgehogs of the Palearctic, Oriental, and Ethiopian regions display the same spiny coat and the same general likeness to *Echidna*, which is therefore sometimes known as the Native Hedgehog.

Certain aboreal Monodelphians, such as the Kinkajou (*Cercoleptes caudivolvulus*), have become modified in their general build of body, as well as in the details of their manus, pes, and prehensile tail, so that they resemble, in most superficial features, the Didelphian Phalangiers, wrongly known throughout Australia as Opossums. Certain of the Australian arboreal marsupials have taken to a parachute method

of gliding through the air, and the Monodelphian convergent mimics of these Flying Phalangiers (*Petaurus*, &c.), are found in such forms as *Anomalurus*—the Flying Squirrels of Central Africa—and in *Pteromys* and *Sciropterus*—the Flying Squirrels of the Oriental Region.

The Australian arboreal marsupial, the Koala (*Phascolarctus cinereus*), which has over-specialised in its arboreal adaptations, and become reduced to the condition of a tree-clinger, finds its Monodelphian parallel in the South American Sloths (*Bradypodidae*) and in the members of the Asiatic Lemurine Genus *Nycticebus*, known as the Slow Loris.

Of the Australian marsupials which have learned to scratch holes in the earth, to provide places for their retreat, one, *Thylacomys lagotis* (the Pinkie or Thulka) has so great a general likeness to a Rodent as to be frequently called the Native Rabbit, and the others (the smaller Bandicoots) have a remarkable resemblance to the Monodelphian rats of the other parts of the world. More striking still is the wonderful convergent mimicry of the Marsupial Mole (*Notoryctes typhlops*) to the true Moles (*Talpidae*), and especially to the Golden Moles (*Chrysochloridae*) of the other land masses of the globe.

The only true cursorial animal developed from the Australian marsupial stock (*Choeropus*) shows several features which mimic in a very close way the modifications seen in the Monodelphian cursorial Rodents and Ungulates.

The saltatory marsupials, of which the Kangaroos are the most perfect example, have their Monodelphian parallels in the Rodent Jerboas (*Dipus*) of Africa, and the Insectivorous Jumping Shrews (*Macroscelididae*) of the Cape, as well as in the indigenous jumping Rodents (*Notomys*) of Australia.

Again, a similar specialisation in diet may effect parallel changes in the two stocks. In this way the carnivorous Didelphian Dasyures have become so like the Monodelphian Carnivora that they are universally known in Australia as Tiger Cats and Native Cats. The little insect-eating marsupials, such as those included in the Genus *Phascogale*, generally known as Pouched Mice, are singularly like the so-called mice and shrews which belong to the Monodelphian Order of the Insectivora. A dependence upon ants as a source of food supply has profoundly altered the Ornithodelphian Porcupine Ant-eater in all things connected with the jaws and tongue, in a way similar to that in which it has modified the same parts of the Didelphian Banded Ant-eater (*Myrmecobius*) of South Australia, and the Monodelphian Ant-eaters (*Myrmecophaga*) of South America.

These instances of Convergence could be greatly multiplied; but enough has been cited to make the reader aware that here, in Australia, there is, perhaps, the grandest manifestation of the biological truth that dissimilar stocks may be modified along similar lines by the demands of similar environmental needs, and that, therefore, rough similarity does not always necessarily denote kinship.

When the first white colonists came to Australia they were confronted by a fauna of which the members were, in a general way, reminiscent of the animal types with which they were familiar in their home lands. And yet, though a general similarity prevailed, there was the great difference, that the whole mode of reproduction, as typified in the pouch or marsupium, was unlike anything that was familiar in the animals they had left behind. It was this circumstance that led to the prefixing of the word "native," or in later times, "marsupial" or "pouched"

to the homely old world name for the animal. In this way we have inherited such names as "Native Cat," "Marsupial Mole," and "Pouched Mouse"—and it can only be said that this is an unsatisfactory scheme of nomenclature.

Familiar names become stereotyped by long usage, and it is to be hoped that in Australia good familiar names for the mammals will one day be forthcoming, and that they will become standardised before the indigenous mammals are extinct. But we must not forget that, even if a popular name is a thoroughly bad one, it is hopeless to attempt to replace it once it has become sufficiently familiar; and no amount of book teaching will ever make the Australian forsake the incorrect name of "Opossum" for the alternative name of "Phalanger." In certain cases there are, however, very good native names for animals, and these terms should be conserved and used wherever possible. Very few people know the book name of "Banded Ant-eater" for the creature whose scientific name is *Myrmecobius fasciatus*, but it has already been provided with the native name of "Numbat," and if ever a familiar name is to be applied to this fast disappearing little animal, no better one could be found.

Again, the name Koala is a far better term for *Phascolarctus cinereus* than is the commonly used "Native Bear"—or the still worse and more recent "Teddy Bear."

There is one other general biological law that is well exemplified by the marsupial fauna of Australia, and this may be termed the Law of the Irreversibility of Evolution. This law is made more easy of understanding by studying an example of its working than by quoting a definition of its terms. Suppose a member of an arboreal stock to become modified by the demands of its environment to a saltatory cursorial mode of life, we know that it would be profoundly altered in the greater portion of its bodily structure. Suppose that, subsequent to this alteration of habit and change of form, circumstances again demanded that it should be a tree-climber, would it be able to alter itself back again and again appear as anything like a genuine arboreal animal? It can alter its habit and environment, but it can never retrace its developmental steps. From being a specialised animal it may become secondarily specialised, or it may degenerate; but it can never retrace its steps and become primitive. There are many reasons for believing that the marsupial stock was primitively arboreal and that its earliest members were predominantly tree-haunting creatures. At the present time several of the most primitive marsupials are true tree climbers. But we know that some, such as the Kangaroos, have become specialised as leaping animals which bound over open spaces. Certain members of this jumping stock have retaken to an arboreal life, and the curious Tree Kangaroos (*Dendrolagus*) of Queensland and New Guinea have carried out the experiment that we have just pictured. Now, although these animals show a considerable aptitude for an arboreal life, and demonstrate numerous re-adaptations to the business of tree climbing, they are not in the least like the typical primitive mammalian type of arboreal animal. Having become committed to a saltatory, cursorial, mode of life they adopted the structural modifications that are associated with that habit; and these modifications prevent them from ever again becoming primitive arboreal animals, although in becoming arboreal, they are probably reverting to an ancestral mode of life. It will be seen from this brief survey of the general problems associated with the Australian mammalian fauna, that no better field of study could be offered to the naturalist and the observer. Every member of the fauna

is worthy of study for its own sake, and around the whole assemblage of species is woven a meshwork of the grandest and most important biological problems. In the Ornithodelphia and the Didelphia. Australia has a heritage for which it must accept responsibility; it must be prepared to conserve the living, to collect and preserve the dead, and to make provision for the proper study of the fauna in all its aspects.

SUB-CLASS I.—ORNITHODELPHIA.

MONOTREMATA OR PROTOTHERIA.

At the present day the Ornithodelphia are restricted to the Papuan and Australian sub-regions; their range extending from New Guinea in the North to Tasmania in the South. Within this region, also, the remains of extinct forms have been found in comparatively recent geological deposits. These extinct forms are in almost every way similar to the main types now living, and they throw but little light upon the history of the sub-class.

Outside the limits of the Australian region the geological evidence of the past history of the Ornithodelphia is by no means clear. Forty years ago Professor Cope called attention to the resemblances which existed between the transient molar teeth of *Ornithorhynchus*, and those which characterise the somewhat heterogeneous group of Mesozoic animals known as the *Multituberculata*. Fragmentary remains of these animals have been found in the Triassic formations of England, the continent of Europe, South Africa, and North America. In most cases nothing, save fragments of lower jaws and odd teeth, has been preserved; the general characters of the whole skeleton being, for the most part, problematical, and merely deduced from a knowledge of the probabilities of correlation of animal structure. Even if we admit a similarity between the form of the molar teeth of the *Multituberculata* and those of *Ornithorhynchus*, we must remember that, in the case of the living animal, we are dealing with teeth which are in a very degenerate condition, and are, therefore, not necessarily typical of the dentition of the ancestral Ornithodelphian. It must also be remembered that the Mesozoic animals also possessed incisor teeth somewhat similar to those seen in the modern Wallabies and Kangaroos, and that such teeth are altogether wanting in the transitory dentition of *Ornithorhynchus*. The discovery of very fragmentary portions of the bones of the shoulder girdle of a North American member of the *Multituberculata*, known as *Camptomys*, makes the affinities of this group with the existing Ornithodelphia rather more probable; but, in the present unsatisfactory state of knowledge of the *Multituberculata*, it is unsafe to dogmatise as to their precise affinities with the existing highly specialised Monotremes of Australia.

Not more than half a dozen living species represent the Sub-class at the present day, and these species, though possessing the very primitive characters which distinguish their Order, are all very highly specialised animals in their own way. It is important to appreciate the specialised, yet primitive, condition of the living Ornithodelphians. It might, at first sight, appear that the terms specialised and primitive, when used to designate the same animal, were contradictory of one another; but in reality it is not so. There is no doubt that the Ornithodelphians constitute the most primitive group of the Mammalia; they are more like the members of the lower vertebrate Classes than are any other Mammals. But there

is equally no doubt that although *Echidna* and *Ornithorhynchus* belong to this very primitive stock, they are themselves very highly specialised animals. Each has become very wonderfully adapted to a rather restricted and highly specialised mode of life ; in this way we have very highly developed structural specialisations grafted on to a ground plan of basal mammalian simplicity.

The very primitive arrangement of the reproductive system of the Monotremes, which earned for them the name of Ornithodelphia (or animals having uteri like birds), naturally led those anatomists, into whose hands the newly discovered animals fell, to believe that some very curious facts concerning the reproductive habits awaited discovery. It did not even seem to be impossible that these very peculiar animals might, in fact, lay eggs as the lower vertebrates do. That the Monotremes were egg-laying animals was several times asserted, and by many naturalists it was believed in ; but some seventy years after the Platypus had first been made known to science, the egg-laying theory was largely discredited. For this curious state of affairs two main factors were responsible. In 1829 Dr. George Bennett first turned his attention to this subject. It is from him that the bulk of the book accounts of the adult animals have come, but he did not succeed in solving the secret of their reproduction. He had the advantage of the knowledge of the blacks whom he employed as hunters, and he devoted some thirty years to the quest, and collected a large number of animals ; but, in the end, he decided that the natives were mistaken when they asserted that the creature laid eggs. His work was published in 1860, and in 1868 Sir Richard Owen wrote, " the balance of evidence is still in favour of the young being brought forth alive." Bennett's failure to find the egg, and Owen's authoritative statement, persuaded most people to the belief that the Monotremes fell into line with the rest of the Mammals in producing living young. It was not until the year 1884 that the investigations of Mr. W. H. Caldwell, of Cambridge University, established the truth of the black-fellows' assertion, and forced the recognition of the egg-laying habits of the Monotremes upon the scientific world. On August 29th, 1884, Mr. Caldwell, who was working on the Burnett River, in Queensland, communicated his discovery that the Monotremes were oviparous to Professor Liversidge, of Sydney University. This message was, at Mr. Caldwell's request, forwarded to the British Association then meeting in Montreal. Caldwell's knowledge was derived from the dissection of a female *Ornithorhynchus* which had laid one egg, and had another fertilised and developing egg ready to be laid. This animal was shot and dissected on August 24th. Meanwhile, Mr. Wm. Haacke was investigating the same question in Adelaide, and on August 25th, in dissecting a female *Echidna*, he found a broken egg in the pouch. This specimen was reported, and exhibited at the meeting of the Royal Society of South Australia on September 2nd, 1884. Confirmation came next from Tasmania, for in October, 1888, Mr. Fletcher, of Campbell Town, in lifting an *Echidna* from its burrow, saw an egg drop from its pouch. The broken egg revealed an embryo, and both egg shell and embryo were preserved. Since 1888 our knowledge of the reproduction of the Ornithodelphia has been steadily increasing, and to-day all the essential facts, and most of the minute details of the process are well established. Within the last few years the patient investigations of Mr. H. Burrell have added a very great deal to the sum of knowledge of the habits and reproductive history of *Ornithorhynchus*.

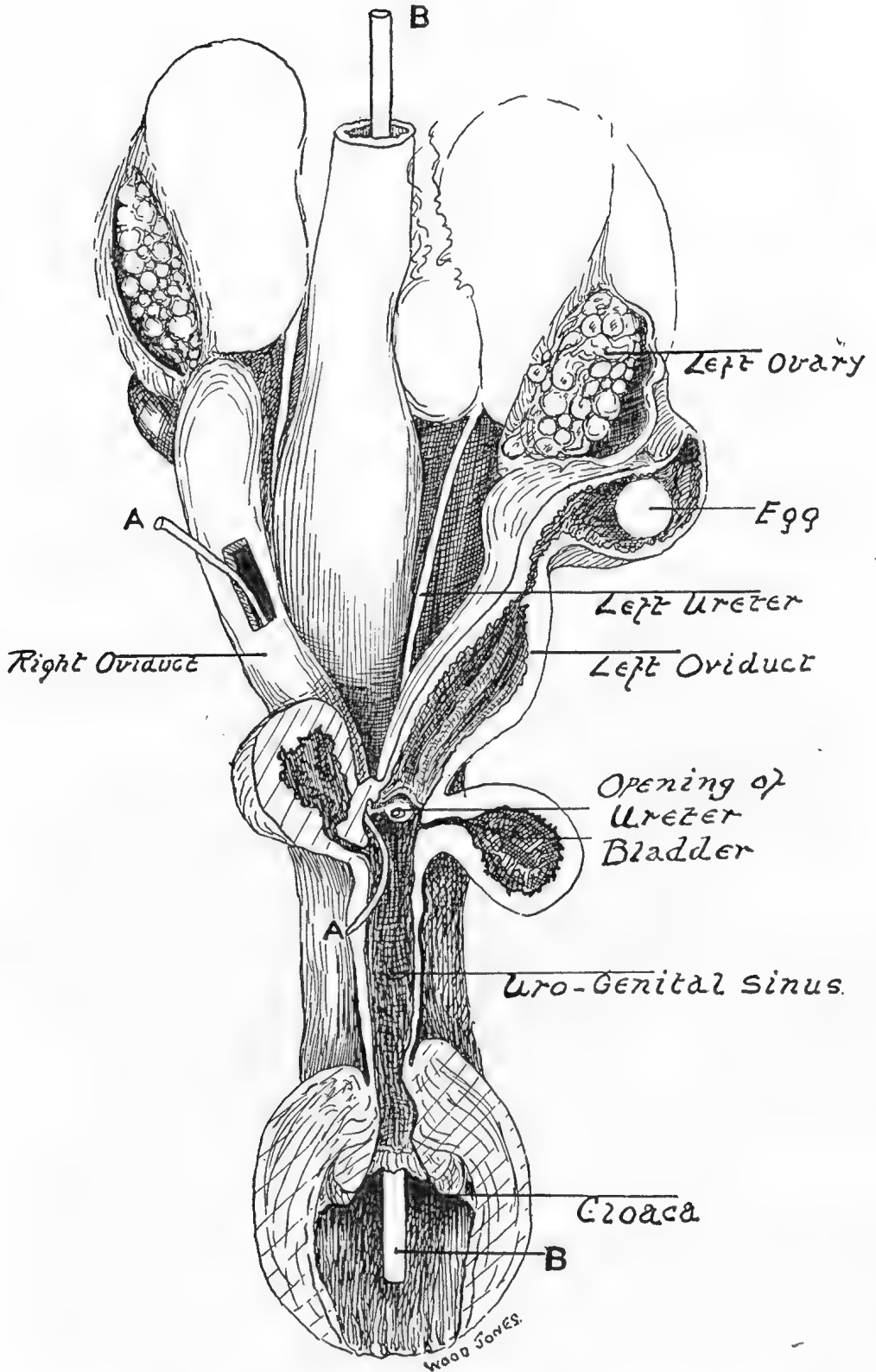


FIGURE 14.—Reproductive system of a female *Echidna* opened from the ventral surface. The bladder has been cut in half, in order to show the various openings of the ducts, etc. The bristle A is passed into a hole cut into the right oviduct and out of the opening into the uro-genital sinus. The rod B is passed through the intestine and out of the intestinal opening into the cloaca.

The two families which constitute the Ornithodelphia differ in certain details, but the main outlines of the general business of reproduction is similar in *Ornithorhynchus* and *Echidna*. In both animals fertilisation takes place in the ordinary mammalian way, and the fertilised egg passes down the oviduct. It is a strange fact that the eggs developed from the left ovary alone appear to undergo development, eggs being found only in the left oviduct. (See Figure 14). This curious unilateral development of maturing egg cells is not accompanied by any obvious unilateral development of the internal genital system, for the right ovary and right oviduct appear to be as well developed as the corresponding parts on the left side.

The monotreme egg is remarkable among mammalian egg cells for its relatively enormous size; for, although it is small when compared with the egg of a bird or a reptile, it is about thirty times as large as the egg cell of Man, or of any of the other higher Mammals. The diameter of the egg as it leaves the ovary is about six millimetres, and this relatively large size is due to the great store of yolk which the egg carries, a condition which in itself is reminiscent of the large yolked eggs of the lower vertebrates. As the fertilised egg passes down the oviduct it undergoes the preliminary stages of development; it increases in size and receives its covering of shell. The shell is largely composed of keratin, a substance which constitutes the leathery covering of the eggs of many of the reptiles and forms the organic basis of the chalky egg shells of some reptiles and all birds. The Monotreme egg is dirty white in colour and oval in shape, but the contour is by no means even, some eggs being actually dented and irregular in their outline.

In the case of *Ornithorhynchus* two eggs are usually laid at a time, but single eggs, and occasionally three eggs, are found in the nest. It is a curious fact that the two eggs are stuck together in their long axis; and so firm is their union that some considerable force is required to separate them. (See Figure 15). The two eggs probably adhere together before they are laid, but Mr. Burrell has noted the strange fact that the two eggs constituting a conjoined pair are usually not exactly the same size. The eggs are about seventeen millimetres long and thirteen millimetres broad when they are extruded from the mother's cloaca; and they are deposited in a nest which has been prepared at the end of a long tunnel in the bank of the water-course or creek in which the animal lives. The eggs are brooded by the mother, and the temperature of the nest is maintained at about 65° F., but they are not received into a pouch for brooding, the ventral abdominal area in *Ornithorhynchus* never being developed into a deep enough depression to serve as an incubatorium. Within the nest the eggs hatch, and at the time of hatching the embryos measure from fifteen to twenty millimetres in length. The newly hatched young has but little outward likeness to the adult; it is in general rather pig-like, and the peculiar "beak" which is so characteristic of the species, is late in its appearance in the developing embryo. It obtains its nourishment by nuzzling among the fur of the mother's ventral abdominal surface.



FIGURE 15.—Two conjoined eggs of *Ornithorhynchus*. This is the commonest condition in which the eggs are found. Twice natural size.

Over this ventral "pouch area" are the openings of the milk ducts, and from these openings the milk is exuded, and is imbibed by the growing young animal. The young *Platypus* remains in the nest until it is covered with hair and is able to fend for itself. The eggs are laid about the middle of September.

Echidna lays only a single egg as a rule, and this egg is some fifteen millimetres in diameter. Within the egg, as it is laid, is an embryo which measures about five millimetres in total length. *Echidna* differs from *Ornithorhynchus* in that at the breeding season (which only occurs once a year) the ventral abdominal "pouch area" deepens, and becomes a functional incubatorium. Into this pouch the egg somehow finds its way. It has been suggested that the female can actually lay the egg into her own pouch by lying on her back and rolling into a ball. The process has not been witnessed, and can therefore only be regarded as an anatomical possibility. There are alternative suggestions. It is obvious that the egg has no power to effect its own translation from the cloaca to the pouch unless it rolls into it or is deliberately put therein. The hands and feet of *Echidna* would seem to be extremely clumsy instruments for transferring the egg, and it would appear to be very probable that the elongated muzzle of the mother is used for this purpose.

Soon after being received into the pouch the egg hatches, and an embryo of about twelve millimetres in length is produced. The naked embryo is a remarkable looking little creature, which evinces the greatest activity whilst still in the pouch; and it obtains its nourishment from the milk ducts which open within the incubatorium. The embryo remains in the pouch until it is about nine or ten centimetres long, at which stage it begins to grow its adult spines. For some time after leaving the pouch the young continues to obtain its nourishment from the mammary ducts which open into the pouch. A period of some ten weeks elapses between the time of impregnation and the period when the young animal quits the pouch. The breeding season appears to be about the middle of September.

In addition to the lowly organisation of the reproductive system there are other portions of the body which show marked differences from the type which prevails among the higher Mammalia. One good indication of the status that an animal occupies in the assemblage of living things is the degree of development to which the architecture of its brain has become carried. The Ornithodelphian brain, although in some of its features further advanced than are those of certain lowly Monodelphians, nevertheless, shows a condition of basal simplicity of organisation when we regard the system of bonds which unite the right and left sides, or hemispheres, of the brain. In the higher Mammals, great masses of nerve fibres, which pass between the most important centres in the two hemispheres of the brain, are gathered together in a dominant connecting bond, known as the *Corpus callosum*. In the Ornithodelphia this bond is absent. (See Figure 16.) The corpus callosum is a cerebral commissure, or a nerve fibre bundle, which keeps the higher centres of the right and left cerebral hemispheres in communication across the middle line of the brain. It cannot be said that the living Monotremes are deficient in the extent of their cerebral hemispheres—they are indeed mysteriously well endowed with cerebral cortex. But it may be asserted—borrowing an expression from the electrician—that their brains are underwired. (Compare Figures 16 and 17.) In the skeleton of the Ornithodelphia there are many evidences of the lowly linkages which the living members of the Sub-class retain. Only two conspicuous

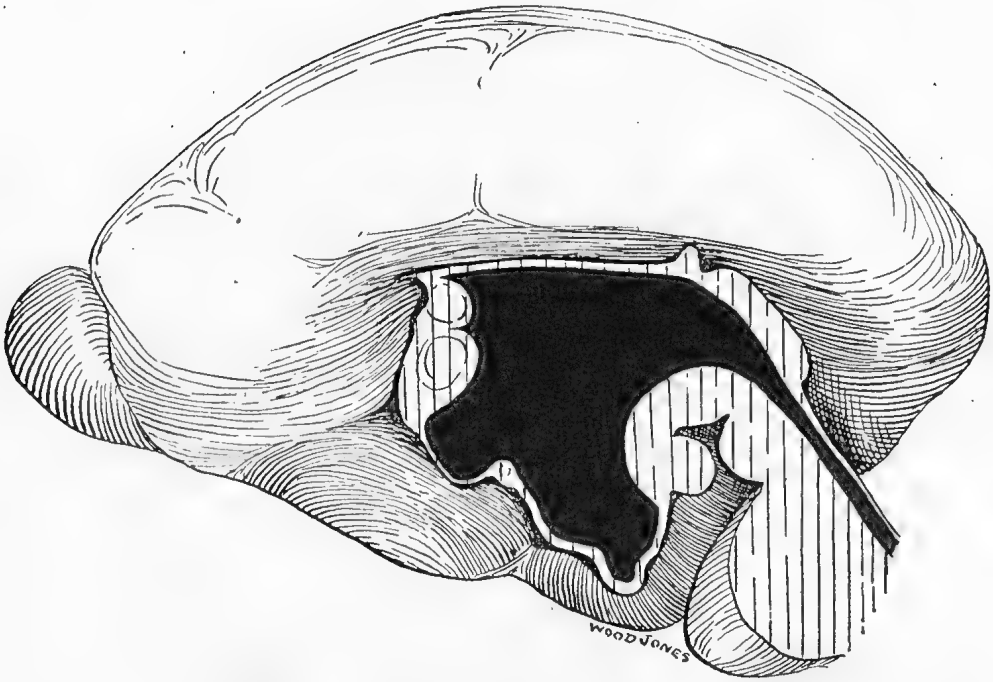


FIGURE 16.—The brain of *Ornithorhynchus*. The brain has been cut into a right and a left half and the figure shows the right half. The parts cut through in separating it from the left half are marked by vertical lines. The black portion is the central cavity of the brain.

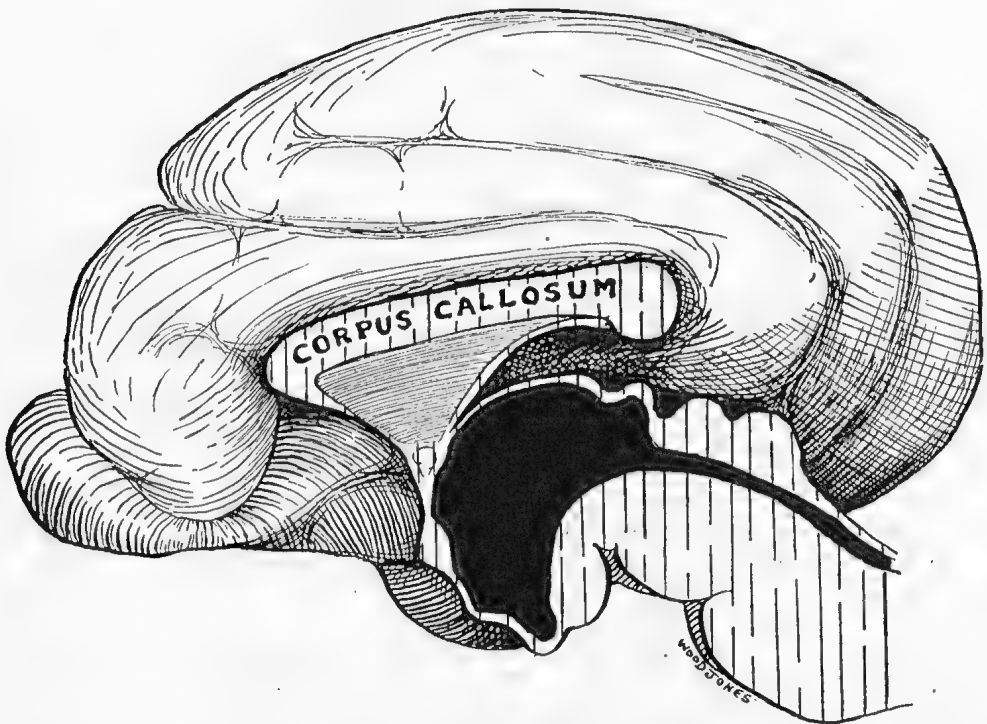


FIGURE 17.—The brain of the domestic cat. This specimen has been prepared in the same way as that of *Ornithorhynchus* shown in Fig. 16. It will be noticed that in the cat a large structure (corpus callosum) has been cut through in severing the two halves of the brain. This structure is absent in the *Ornithorhynchus*.

osteological features need detain us here for explanation and illustration. A clear remnant of kinship with the lower vertebrates, such as the Reptiles, is shown in the arrangement, and relative development of the bones which keep the fore limb poised at the side of the body. In *Echidna* and in *Ornithorhynchus*, just as in the Reptiles, a bone, which takes part in making the socket for the arm at the shoulder joint, runs from the joint to the ventral mid-line of the body to join the breast-bone (sternum). This bone, which is named the *Coracoid*, keeps the shoulder joint fixed

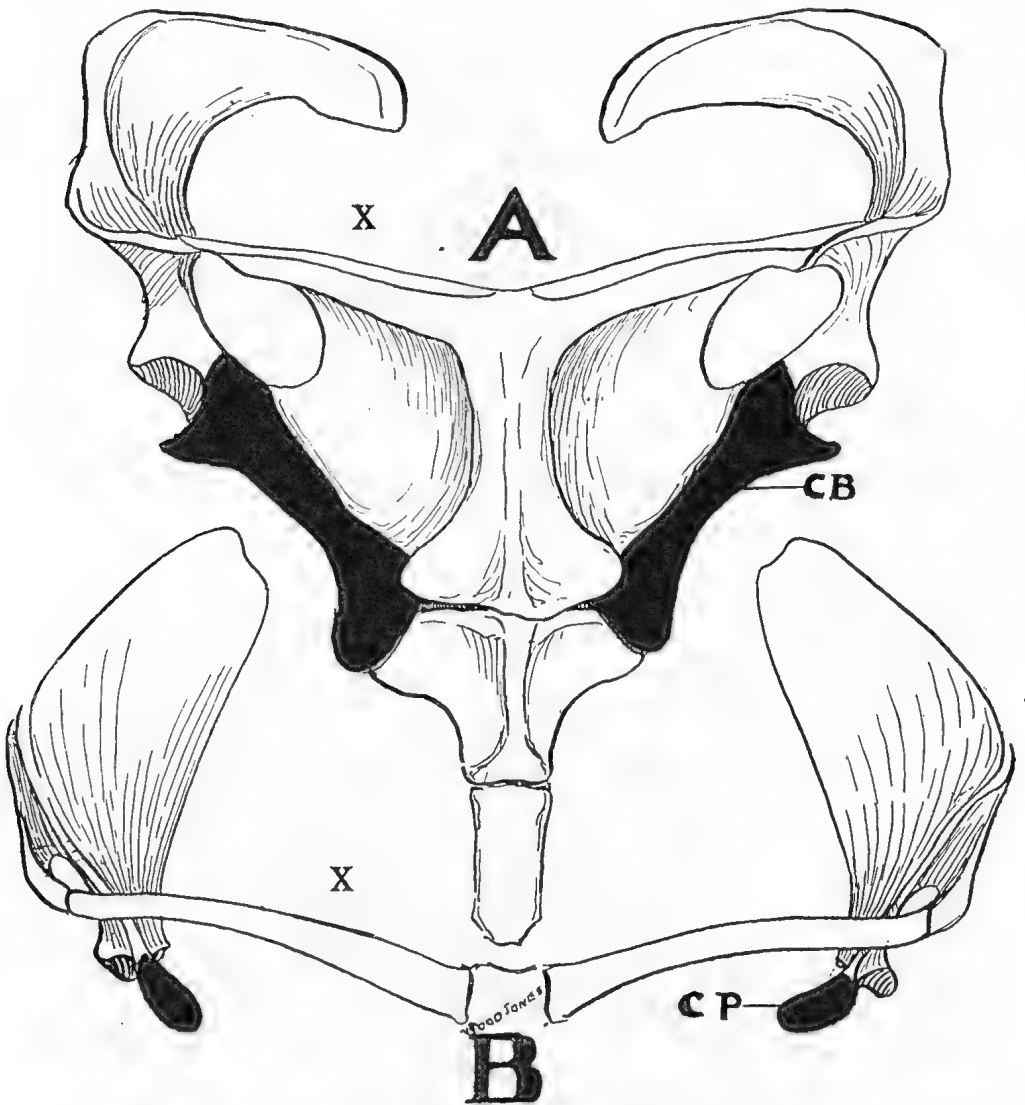


FIGURE 18.—A, The shoulder girdle of *Ornithorhynchus* contrasted with B, a diagrammatic plan of the human shoulder girdle. The coracoid bone (CB) and the coracoid process (CP) are represented black. The clavicle is distinguished by X.

firmly to the rest of the skeleton. (See Figure 18, A.) But in all Mammals except the Ornithodelphia, the Coracoid bone has become reduced, and it does not come so far towards the middle line as to join the sternum. Then the shoulder is held to the rest of the skeleton only by the collar bone (Clavicle), marked X in Figure 18. When the Coracoid becomes reduced it turns into a mere knob on the shoulder, or blade bone (scapula), and it is then known as the Coracoid Process.

In Figure 18 the well developed coracoid bone of *Ornithorhynchus* has been contrasted with the comparatively insignificant process seen in Man. But it must not be thought from this that the human coracoid process is to be reckoned as a small one, when comparison is made with most other Mammals. The coracoid process of Man is far larger than the corresponding process in the kangaroo, for instance, though it is very small when compared with the fully developed bone of *Ornithorhynchus*.

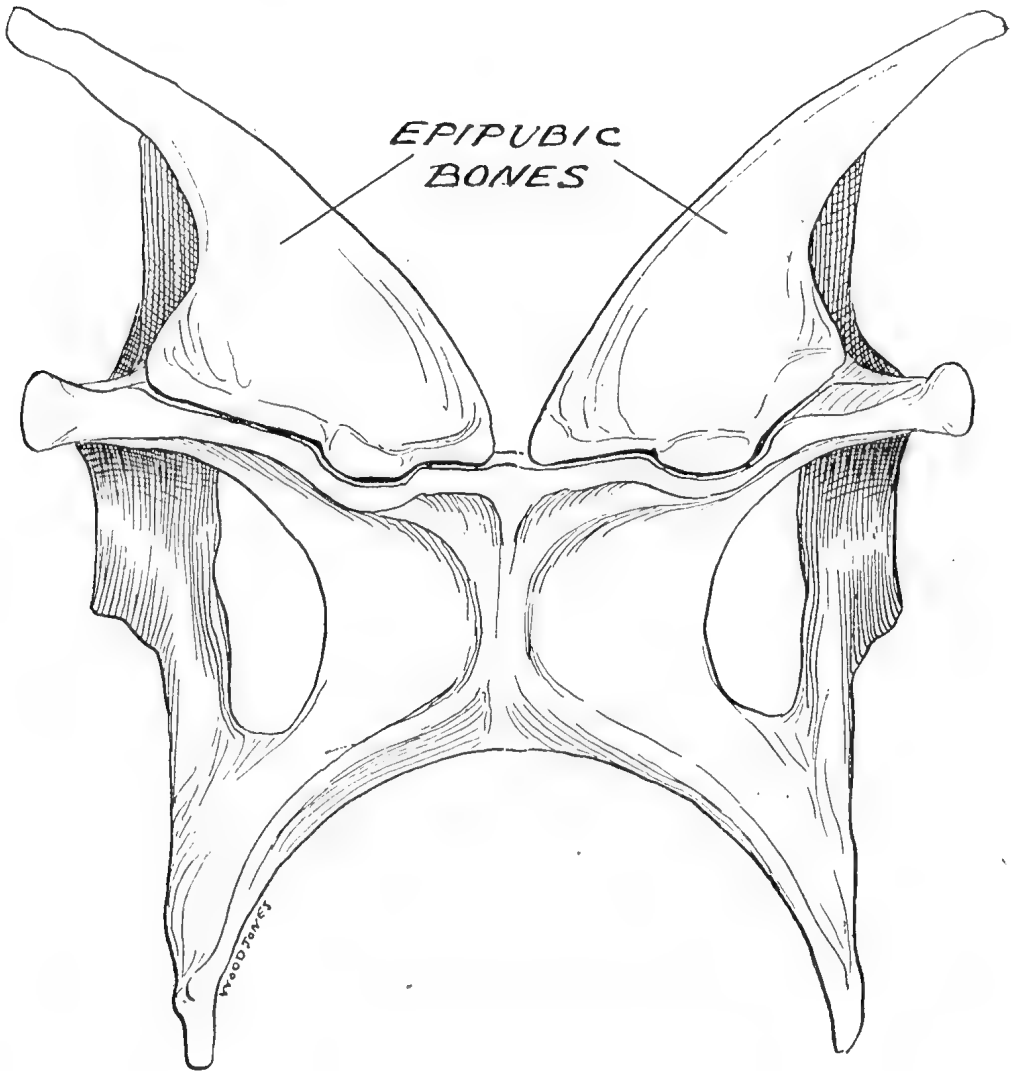


FIGURE 19.—The pelvis of *Ornithorhynchus* showing the epipubic or “marsupial” bones.

The completeness of the shoulder girdle is peculiar to the Ornithodelphia among Mammals ; in the same Sub-class the bony support for the hind limb (pelvic girdle) also shows a very interesting peculiarity. Upon the cephalic end of the ventral surface of the pelvis are two large flat bones, only lightly joined to the other bones of the pelvis, and curving forwards and outwards from the middle line as two partial crescents. The bones are embedded in the muscles of the wall of the abdominal cavity, and are evidently structures developed in connection with the strengthening of the abdominal wall, rather than in connection with the support of the hind limb.

These bones are known as *Epipubic* bones, and they are present both in the *Ornithodelphia* and in the *Didelphia*. From the fact that they are most familiar in the skeletons of Marsupials, they are often wrongly known as the "marsupial" bones, but they are present in males as well as females; and in pouchless forms as well as in pouched species: those from the pouchless *Ornithorhynchus* are illustrated in Figure 19. They are not present, as developed elements, in the *Monodelphia*, but similar structures are found well developed in Reptiles.

The question of the poisonous properties of the Monotremes is one that has been

many times discussed, and one that frequently claims attention in the columns of the newspapers. Widely differing opinions are entertained upon this subject, and these opinions are often held with a considerable amount of conviction. It will, therefore, be most profitable to avoid stating opinions, no matter how authoritative such opinions may be, and to limit this very brief account to the plain presentation of such well determined facts as are obtainable.

In the first place the structures that are related to the supposedly venomous function have been repeatedly investigated and the naked-eye anatomy and the microscopic details of these structures are thoroughly well known. In *Ornithorhynchus*, a large, whitish, somewhat horse-shoe shaped gland—named the Crural, Femoral or Poison gland—is situated at the dorsal aspect of the upper part of the hind limb. In size the gland is about 30 millimetres long, 20 millimetres wide, and about 15 millimetres thick. It is peculiar

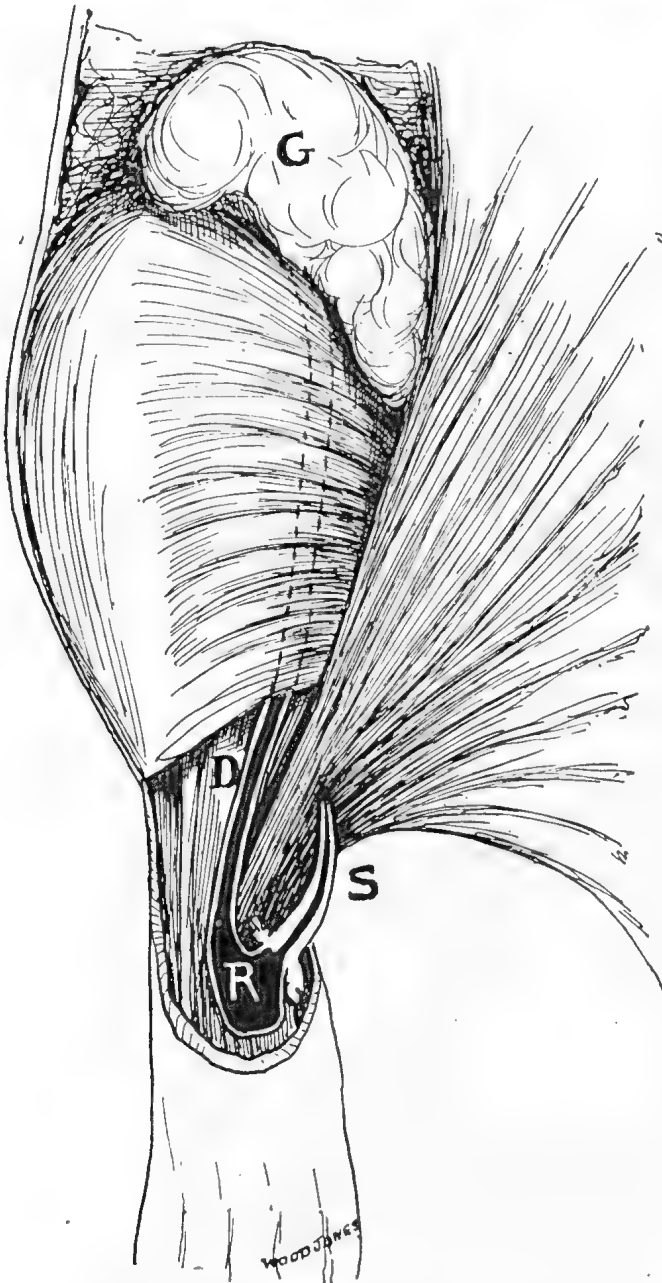


FIGURE 20.—Femoral or poison gland (G), duct (D), and spur (S) of a male *Ornithorhynchus*. The specimen is dissected from the dorsal aspect, and the gland of the left side is shown. R=the reservoir at the base of the spine.

to the male. The gland has the typical structure of a secreting gland, and the substance which it secretes passes from the gland, down a duct which runs along the back of the leg, and thence to the canal which runs through the hollow spur situated upon the inner side of the ankle. The normal condition is shown in Figure 20. The whole system is subject to seasonal variations in functional activity, and in relative development. In *Echidna* the system is not so well developed. The gland, which is situated lower down the leg, in the region of the back of the knee, is only about the size of a pea, and the spur is not so large or so formidable a weapon as that of the Platypus.

The secretion which is poured out from the gland in the Platypus, and which passes down the duct and to the hollow spur, and to any wound inflicted by the spur, is "practically a solution of proteids, chiefly albumin, but also proteose" (Martin and Tidswell).

So much for the anatomical condition of the system under discussion: we are dealing with well ascertained facts recorded by trained observers. When we come to inquire as to the use which the living animal makes of this system, we become sensible that there is less guarantee of accuracy in the range of observed facts dealing with function than we encountered when dealing with structure. Thoroughly reliable observations, however, carry us this far. The male *Ornithorhynchus* can, and at times does, strike with its spurs when handled. The spurs are capable of inflicting a wound, and this wound is followed by definite symptoms. The symptoms are somewhat akin to those present in cases of non-fatal snakebite, and men and dogs are equally affected when wounded by the spur. So far as I can ascertain, no recorded observations have ever given support to any of the various opinions that the apparatus has functions other than that of an offensive and defensive weapon. That the recorded observations show that the spur is not invariably made use of when the animal is handled, is of little moment.

When we pass further on, and inquire as to the effect of the secretion of the femoral gland when injected into animals, we again come into the realm of exact experiment and observation. Drs. Martin and Tidswell injected the secretion, in varying doses, into rabbits; and they found that it possessed a decidedly poisonous character. The rabbits showed, as minimum symptoms, local swelling and drowsiness, and as a maximum, death with convulsions within 90 seconds; the symptoms depending upon the dose and method of administering it.

We may say, therefore, that the male Monotreme possesses a secreting gland, a duct, and a hollow spur, as an anatomical entity. That the gland undergoes seasonal changes in activity; that its secretion, when injected into animals, is decidedly poisonous, and that its composition, and its effects, are probably akin to those of snake venom. That the symptoms, produced by the experimental injection of the secretion into animals, are similar to those described in well-authenticated cases of wounding of men, or dogs, by the spur of the living male Platypus.

Because we have limited ourselves to the statement of certain well ascertained facts concerning its use as a weapon, it must not be imagined that it is considered impossible that the animal may put the spur to other uses. The Monotremes are not easy animals to observe, and possibly many of their habits remain quite unknown for lack of proper opportunities for observation. But there is little to

be gained by mere speculation as to the function of structures found in living animals. Observation of the living creature is required. Speculation may be invoked if, unfortunately, the animal becomes extinct before the point has been determined by direct observation.

In many accounts of the relationships of the Monotremes to the rest of the Mammals, considerable stress is laid upon certain physiological factors in the economy of the living members of the Sub-class. Reptilian affinities have been argued not only from the fact of the secretion of poison from a gland, but also from the oft-repeated assertion that, to all intents and purposes, the Monotremes are cold-blooded animals, or animals which do not possess the power of maintaining a constant body temperature. Even though we may be free to admit that no function, save that of a poisonous one, has as yet been reasonably assigned to the femoral gland and calcaneal spur of the Monotreme, we have no need to suppose that in this function any physiological affinity with the venomous Reptiles is manifested.

In the same way we must admit that the body temperature of the Monotreme is unusually low ; but that is not to agree that they are akin to the Reptiles in failing to maintain their body temperatures within certain fairly definite limits.

The temperatures of seven females of the Platypus were taken by Mr. Burrell. These females were removed from their nesting chambers, and the observations were made in September. The temperatures of these animals ranged between 30° C. and 33° C., and the average of all the observations was 32.2° C.

Of *Echidna* there are many temperature records, since it is an animal which is easily kept and examined in captivity. Miklouho-Maclay, in 1879, examined a series of "porcupines," and concluded that their temperature ranged between such low figures as from 26.95° C. and 28.3° C. In 1886, R. von Lendenfeld, as the result of a series of observations, concluded that the body temperature was higher but more variable, and gave the extremes as 28° C. and 35° C. Semon, in 1894, gave 26.5° C. to 34° C. as the range for *Echidna*. Sutherland, in 1897, found it to be as wide as from 22° C. to 36° C. Dr. C. J. Martin reinvestigated the question in 1902, and during the last few years Dr. Wardlaw has made innumerable observations, and, thanks to his work, we may say that the peculiarities of the body temperature of the Monotremes are now well known.

The temperature of the higher Mammals varies within fairly wide limits, and in the different species that have been examined it ranges from about 36° C. upwards for a few degrees. It is therefore obvious that both *Ornithorhynchus*, with its average of 32.2° C., and *Echidna*, with its average of 31.1° C., are creatures of relatively low temperature ; but the difference between the Monotreme temperature and that of other Mammals is not nearly so great as it is often asserted to be. It must also be remembered that our knowledge of the temperatures of some of the lower Monodelphia is scanty, and it is possible that *Echidna* and *Ornithorhynchus* do not stand very far apart from some of the more sluggish and least advanced of the higher Mammals in the matter of their bodily heat. Again, the fact that the temperature of the Monotremes varies at different times of the day does not confer on them the distinction that some writers have imagined. Dr. Wardlaw determined that the morning temperature was always lower than the afternoon temperature ; but the same is true of the higher Mammals and of man. Semon noted this varia-

tion in the temperature, but confessed that "a relation between these changes and the changing temperature of the outer air could, however, not be proved." That is to say, although the temperature of *Echidna* is variable its rise and fall does not correspond with the rise and fall of the temperature of its surroundings, as is the case with the lower Vertebrates. There is, nevertheless, a time when the temperature of *Echidna* does tend to follow the temperature of the outside air, and when the Monotreme can be said to behave somewhat like a "cold-blooded" or poikilothermic animal. This is during that period of the year when the animal undergoes a partial hybernation or aestivation. In the summer Dr. Wardlaw's animals averaged 30° C. in the morning and 32·6° C. in the afternoon; but in the winter the morning temperature was 29·7° C. and the afternoon was 32·3° C.; but this fall in winter temperature is found in all hybernating or partially hybernating animals; and it can only be said that the Monotremes are animals having a rather low body temperature, but, nevertheless, being truly homiothermic (or "warm-blooded") within certain limits of temperature, and in the non-hybernating period. They have a typically good mammalian heat regulating mechanism effective between 27·6° C. and 32·6° C.; and it is only when the temperature is raised or lowered beyond these limits that the regulation tends to break down, and they behave as poikilothermic animals.

Having discussed some of the outstanding anatomical and physiological peculiarities of the Ornithodelphia, we are now in a position to define the Sub-Class and to inquire into the methods of classification of its representatives.

KEY TO THE SUB-CLASS.

Oviparous Mammals, having simple oviducts opening separately into a Cloaca. No external nipples are present. In the brain the Corpus Callosum is lacking. There is a T-shaped episternum. The Coracoid processes are prolonged to meet the sternum. The cervical vertebrae bear ribs. There are well developed Epi-pubic bones.

The animals falling within the Sub Class may be separated into two groups as follows :—

- (A) Without teeth at any stage. With the muzzle elongated as a cylindrical snout. Feet not webbed. Hair mixed with sharp bristles.

Echidnidae.

- (A¹) With temporary teeth, afterwards replaced by horny plates. With the muzzle prolonged as a flattened beak. Feet webbed. Hair free from bristles.

Ornithorhynchidae.

FAMILY I.—ECHIDNIDAE.

Of the two Genera into which this Family is divided only one is represented in continental Australia.

(A) With the elongated muzzle straight and not greatly prolonged. Snout shorter than the head, *Echidna*.

(A¹) With the elongated muzzle greatly prolonged and curved downwards. Snout longer than the head *Zaglossus*.

The Genus *Zaglossus* is confined to New Guinea, and does not concern us here. The Genus *Echidna* ranges from New Guinea to Tasmania.

GENUS.—ECHIDNA (Georges Cuvier, 1798, Nom. Conserv.).

It is now generally admitted that the Genus *Echidna* contains but a single species. Within the very wide limits of its geographical range this species is subject to very considerable variation. Variation is shown in several directions—(1) The general body size; (2) the proportion of spines to hair in the general body covering; (3) the general color of the hair and spines; and (4) the length and thickness of the spines themselves. The name of the single variable species is *Echidna aculeata* (Shaw, 1792), and the various geographical races are given additional sub-specific names.

The form which inhabits Australia as a whole (as distinct from New Guinea or Tasmania) is known as *Echidna aculeata typica* (Thomas, 1885); and a separate name, *Echidna aculeata multiaculeata*, was given by Rothschild in 1905, to the race inhabiting the extreme south of South Australia.

(1) Native Porcupine, Porcupine Ant-eater, Spiny Ant-eater, Australian Hedgehog.

ECHIDNA ACULEATA TYPICA (Thomas, 1885).

The region of the face is covered by brownish, flattened, bristle-like hairs, intermixed with finer cylindrical hair of a paler colour. A patch of cylindrical hairs is present around the opening of each ear. The site of the ear is somewhat variable in its appearance. As a rule, it is easily seen as an area where the spines on the side of the face show a parting, and reveal a hairy interval. The spines at this point are often disposed in a whorled manner, and the ear is apparent as a depression in the centre of the whorl. By a curious mistake the artist who depicted this animal in Krefft's "Mammals of Australia," placed the eye in this depression, and so imparted a very strange expression to the usually somewhat expressionless face of the *Echidna*. At times a true pinna, or auricle, is developed in some degree, and a little hairy tuft projects at the top and back of the orifice for the ear. The dorsal surface of the whole of the body is covered with flattened bristle-hairs intermixed with cylindrical spines. The degree to which the hairs are hidden by the spines, or project above the spines, is variable. The spines of the back are about 60 millimetres in their maximum length and, as a general rule, the larger the spine the lighter is its colour. Some of the largest spines are coloured pale straw yellow in the whole of their length, but the majority are tipped with black, which gradually fades to brown, and finally to yellow towards the base of the spine. The smaller

spines are brownish black throughout their length, but in all cases the base is paler than the tip. Upon the sides of the body the spines slope uniformly backwards towards the caudal end of the body ; but upon the dorsal surface the spines are

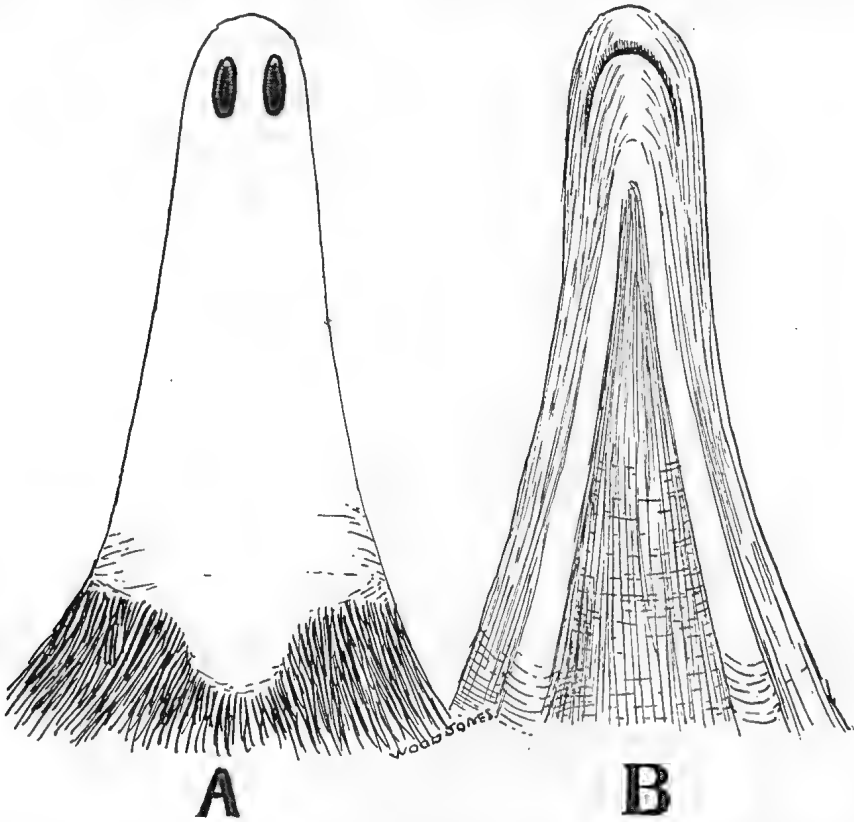


FIGURE 21.—The muzzle of *Echidna*. A, from above, showing the nostrils. B, from below, showing the mouth. From a female specimen. Twice natural size.

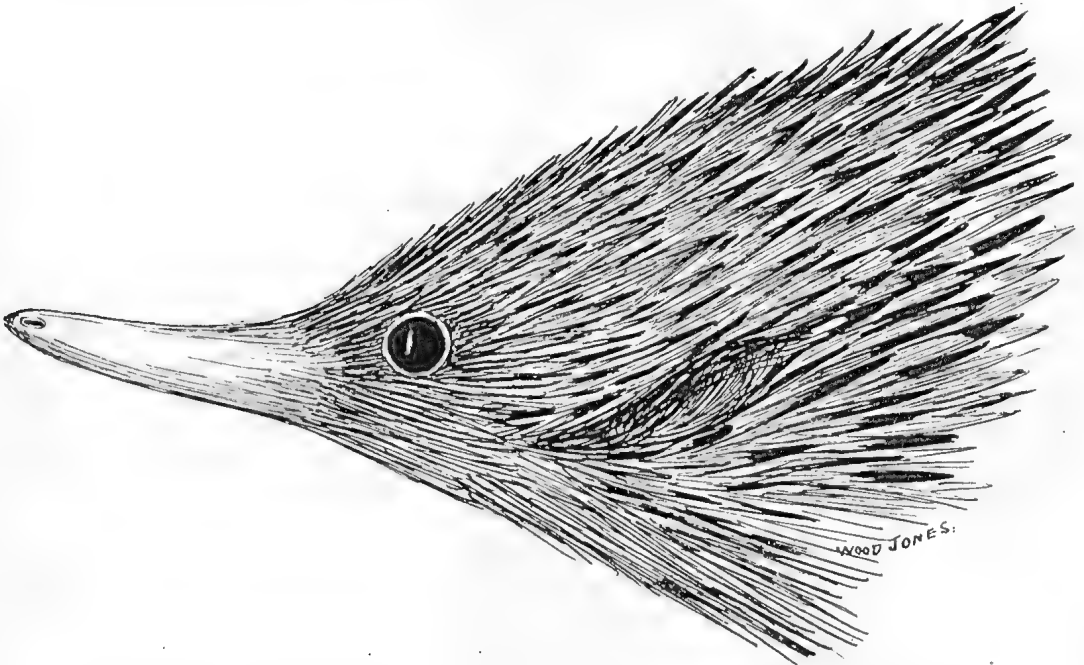


FIGURE 22.—Head of *Echidna*. Drawn from a female specimen. Natural size.

also directed towards the middle line. In the middle dorsal line a convergent track of spines is present; and the spines derived from the two sides of the body usually cross their points along the mid line in a very regular manner.

The limbs and the underside are free of spines and are clothed with coarse brown hair thickly intermixed with flat bristles. The actual tail is a mere stump, only about half an inch long, but the spines of the caudal extremity of the body stand erect in distinction to the spines of the general dorsal area and produce a conspicuous terminal tuft of spines, and this arrangement exaggerates the appearance of the tail.

The elongated and sensitive snout terminates in a bluntly rounded extremity. See Figure 21. There is a very slight tendency for the whole snout to be turned somewhat upwards at its tip. The nostrils are dorsal in position and are simple;

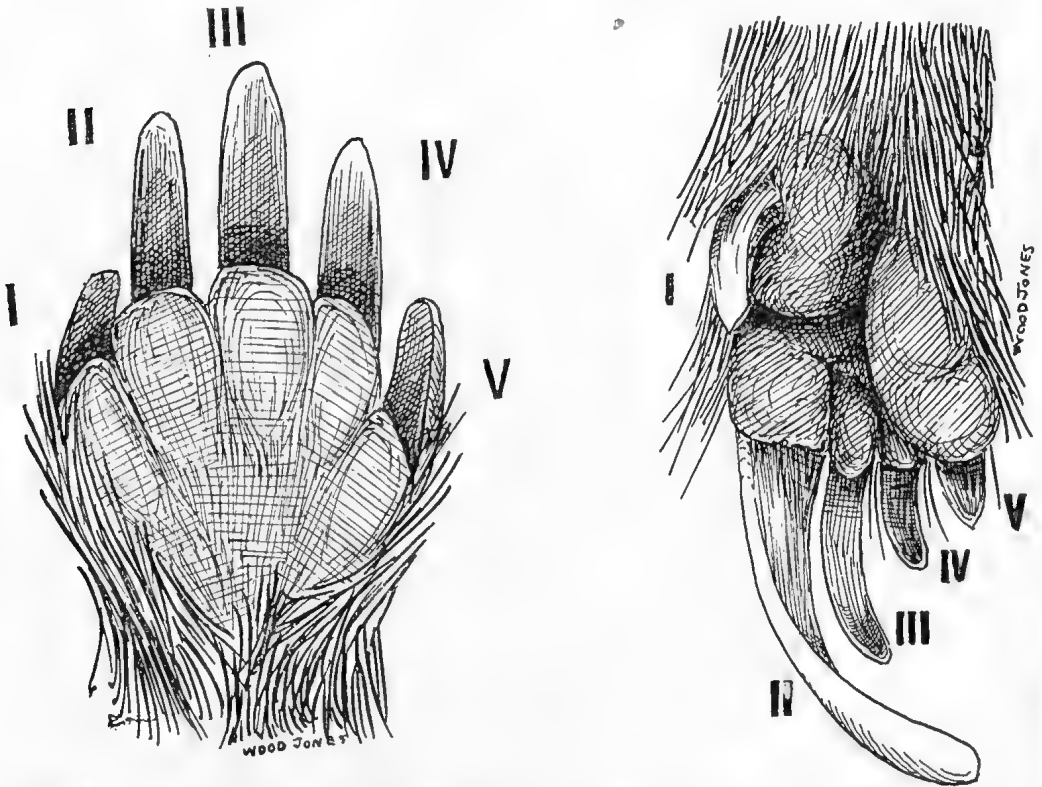


FIGURE 23.—The left manus and right pes of a female *Echidna*. Note the enlarged 2nd pedal digit, which is a specialised “toilet” digit. Natural size.

they are elongated in the long axis of the snout. The opening of the mouth is very small, and is sufficient only for the protrusion of the tongue. Dark eyelashes are developed upon both upper and lower eyelids. The pupil is circular, the iris dark-brown. There are no obvious “whiskers” or other sensory vibrissae upon the face, or upon any other part of the body. See Figure 22. The calcaneal spur is black in colour, and is partly concealed within a depression of the skin above the ankle.

In the manus the five strong digits are all armed with stout spatulate claws. The palm is naked, the skin simple. Pads are only poorly defined. The digital formula is $3 > 2 > 4 > 1 > 5$. See Figure 23. The integument of the manus is continued in a rather remarkable manner into the interdigital spaces, and when looked at from the dorsal surface the digging manus has a distinctly webbed appear-

ance. See Figure 24. The digits of the pes are considerably specialised, and the second, which is by far the largest, carries a greatly enlarged and curved claw. This remarkable claw is often regarded as a specialisation for digging; but it is a structure which belongs to a far more interesting category of adaptations of form to function. The spiny coat of the *Echidna* renders it difficult for the animal to cleanse its body by the common mammalian process of scratching, and it is for the purpose of reaching the skin of the body between the spines that this long curved claw is developed. The elongated claw and specialised character of the second pedal digit constitute a *toilet digit*, or a hair comb; and they are not specialised for the mere function of digging into the earth. The pedal digital formula is $2 > 3 > 4 > 5 > 1$.

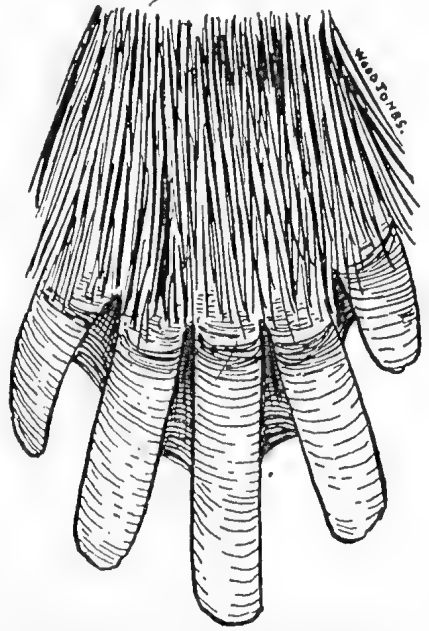


FIGURE 24.—Right manus of *Echidna*, seen from its dorsal surface to show the pseudo-webbing of the claws. Natural size.

The animal varies a good deal in size, but apparently the two sexes do not differ markedly in their measurements. An average South Australian specimen gives the following figures :—

Length of head and body	400 mm.
Tip of snout to eye	50 mm.
Tip of snout to ear	85 mm.

(2) *ECHIDNA ACULEATA MULTIACULEATA* (Rothschild 1905).

This sub-species differs from the typical form in possessing more numerous longer, thinner, and paler spines. The spines are more finely tapering than are those of the common variety, and the hair of the head, legs, and underside is pale yellowish-brown.

The sub-species was described from the extreme south of South Australia, but it is to be noted that specimens from the extreme north of the State are also remarkable for the pale colour of their hair and spines.

Examples from Kangaroo Island are usually recognisable by their pale and abundant spines.

The *Echidna* is an animal which is extremely difficult to observe in its natural state, and accounts of its habits have, for the most part, to be taken from observations made upon captive animals. It is crepuscular or nocturnal in its activities, and obscure in all its ways of life. In captivity it readily becomes accustomed to feeding during daylight, but it reserves most of its activities for the darkness.

The animal is a burrower of the most remarkable kind, and its powers of clinging to, and sinking into the earth, can hardly be appreciated by those who have not witnessed the process. If an *Echidna* be placed upon a hard surface into which it is unable to burrow, it is capable of making off at a good pace; but the moment that it encounters ground into which it can dig, it ceases all attempts to escape

by shuffling along, and proceeds at once to sink directly downwards into the earth. In this process it does not burrow in head first, as do most burrowing animals; but it sinks in, in a way that can only be described as all-over-at-once. If it be interfered with in the preliminary stages of this process of digging itself in, it will be found that the animal appears to be miraculously stuck to the ground; and, once it has started to descend, it is almost impossible to arrest its progress and, draw it back.

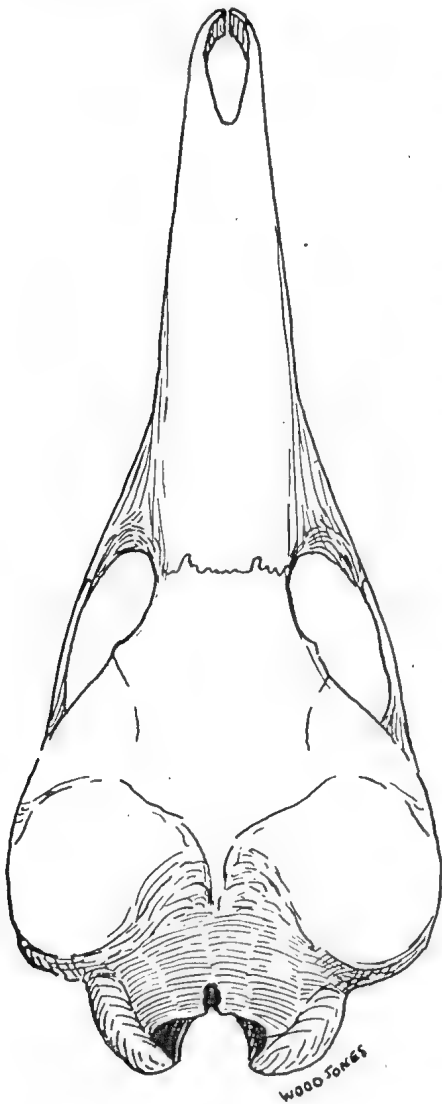


FIGURE 25.—Skull of *Echidna* viewed from above. Natural size. The specimen from an animal obtained at Mount Gambier.

Although these extraordinary powers of digging are commonly said to be the natural endowment of an animal which obtains its food by “digging up the ant or termites’ nests with its powerful limbs,” this time-honoured explanation is far from satisfactory. The digging of *Echidna* in its normal manifestation is certainly a protective mechanism; it is an elaborated method of avoiding its enemies, rather than a perfected means of obtaining its food. Even when it is quite unable to dig below the surface, it still shows its wonderful powers of clinging to the earth, for given any irregularities of surface of which it can take advantage, it will manage to wedge itself so securely, by the aid of its stout feet and its bristles, that it is practically impossible for an enemy to dislodge or even to injure it. In the same way it will wedge itself into the corner of its cage when confined; and an extension of the same process permits it to ascend the corner of its box in a manner rather surprising in an animal which has, apparently, so little adaptation to climbing activities. Its strength is very remarkable, and it is difficult to devise any cage in which it can be kept under observation, for its stout little limbs, and powerful claws, are capable of tearing a way through most materials.

Some idea of the strength of the animal may be gained from the experience of an Adelaide zoologist who put an *Echidna* in his kitchen for the night. Next morning all the furniture—the heavy dresser, the table, chairs, boxes, etc.—was found moved from the walls towards the middle of the room. The gas stove, which was fixed by its pipe, alone withstood the animal’s efforts at removal.

Although so apparently dull an animal, it resents captivity acutely, and, in general, it may be said of captive specimens, that their whole energies are so thoroughly absorbed in attempting to regain their liberty, that the normal

behaviour of the creature is difficult to appreciate from observing animals kept in confinement.

In finding its way about, the sensitive snout obviously plays an important part, and everything is tested by being probed with the tapering end of the muzzle. In this testing it is not only the sensitive skin which is called into play, for, judging by the frequent inspiratory sniffs which form the accompaniment of most of its activities, the sense of smell is an important guiding factor.

Its vision does not appear to be at all acute ; and its range is apparently restricted to comparatively near objects. The sense of hearing, on the other hand, is evidently well developed, and the animal has an altogether extraordinary power of appreciating, either by auditory impressions, or by a tactile sense of vibrations, the advent of an approaching footfall.

Its only vocal accomplishment appears to consist in varying modulations, and amplifications, of the sniff through its nostrils.

Although the *Echidna* is often assumed to be solely a destroyer of "white ants" or termites, and is commonly depicted in the act of tearing into a termites' mound, it is, in South Australia at least, an animal which devours a variety of small insects. Doubtless in those parts of Australia where termites are extremely abundant the *Echidna* takes advantage of so vast a store of easily obtainable food, but true hymenopterous ants are the insects of which it takes the greatest toll in South Australia. The small black ants, known as "Sugar Ants," constitute the most abundant and the most usual contents of the intestines ; and, though other insects are found in varying quantities, there can be no doubt that *Campanotus nigrescens* is the staple article of diet.

In confinement *Echidna* will drink milk in most remarkable quantities. It will also eat bread and milk, finely chopped hard-boiled egg, or indeed any food substance which can be reduced to a suitable consistency. The gape of the jaws is so small that the mouth opens no further than to permit the long tongue being protruded and retracted at a rapid rate. Any animal substance which can adhere to the tongue, and be withdrawn with it into the mouth, appears to be appreciated by the "Porcupine," but it has a special liking for a raw egg with a hole made in it to admit the tongue.

It thrives well upon such a diet in captivity. Although so extremely fond of milk it appears to have little aptitude for drinking in the ordinary way. The nostrils are situated so near to the end of the snout that when it dips its nose into fluid they become immersed, and its drinking is interrupted with frequent snufflings as its nostrils become filled with fluid. It can survive for a very long while when deprived of fluid or of food ; its power of fasting being truly reptilian. It is said that it will easily exist for a month without any nourishment ; and this is doubtless true, for the animal normally undergoes a more or less complete hibernation.

Its power of recovering from severe wounds ; its tenacity of life ; and its extremely slow death, even when mortally stricken, are all reminiscent of the lower Vertebrates. It is usually said that *Echidna* prefers rocky, or sandy, country in which to dwell, but its distribution throughout the State shows that no one type of country can be said to be its elective or exclusive habitat. It has a remarkably wide distribution in South Australia, extending from the arid Centre to the coast and to Kangaroo Island. At the present time the "Porcupine" is in no immediate

danger of extermination. Fortunately for itself it is of no commercial value. It has no useful, or ornamental skin to attract the trapper, and since it has ceased to be a desirable article of diet for the aboriginal it is in the happy position of being practically useless to man. It does not in any way actively harm any human enterprise, and so it does not fall under the ban of the exterminator. Again, it has two other great assets—it is not attracted by the poison bait, and it is nearly fox-proof. Only the rabbit and the rabbit trapper are capable of appreciably interfering with the continuity of its archaic story. The burrowing rabbit, in all places in which it is abundant, causes a house shortage for other burrowers. The competition for breeding burrows is a very real factor, and it enters into the lives of some of the Marsupials even more acutely than it does in the case of *Echidna*. Again, the steel trap, intended for the rabbit, will often catch the unsuspecting Ant-eater. It is so obscure in its ways that its presence is not always suspected, and, although nowhere existing in great numbers, it retains a tenacious hold on a very wide area of country, in which, it is hoped, it will long remain unmolested.

FAMILY II.—ORNITHORHYNCHIDAE.

The Family contains only a single Genus.

GENUS.—ORNITHORHYNCHUS (Blumenbach, 1800).

Despite the fact that, in the colour and texture of the fur, considerable variation is displayed by animals representing different localities, seasons, or periods of life, it is usually admitted that there is only one species of Ornithorhynchus.

The fact that the male and female are normally rather different in size, and coat condition is somewhat variable, has led to the description of several species, and at least half a dozen of these have, from time to time, received specific names. Here, however, all forms will be considered under the single specific title.

Platypus, Duckmole, Duckbill, or Watermole.

ORNITHORHYNCHUS ANATINUS (Shaw, 1799).

In general form the animal is strikingly flat; the face, the head, the body, and the tail being flattened from above downwards. The whole bodily adaptation is obviously that of a surface swimmer.

The Platypus is clothed with a dense fur, which consists of a beautifully soft woolly underfur, concealed by a longer, harsher coat of shining hairs. The general colour of the dorsal surface of the head and body, and of the outer aspect of the limbs, is a deep umber brown, looking, of course, a great deal darker when the animal is wet. The ventral surface and the inner aspect of the limbs is slightly paler than the general body colour. There is said to be a "white or yellowish" area around each eye; but this area, though almost always emphasised in text-book accounts of the animal, is not invariably present. Hair extends only just beyond the wrist upon the back of the manus; but on the pes, hair is present right down to the extremities of the digits.

There are no sensory vibrissae or papillae upon the face or limbs. The naked skin of the flattened muzzle, or "beak," is of a suffused, purplish, slate-colour above, and

pale flesh-coloured, or mottled below ; and it is extremely delicate in texture. The dorsal surface is finely marked by minute pores, somewhat like those seen on the skin of the palm of the human hand. From the flattened dorsal portion of the beak a free fold of the same delicate naked skin is carried back over the anterior part of the fur-covered face. This fold forms a sort of shield, extending backwards almost as far as the eye, as shown in Figure 26.

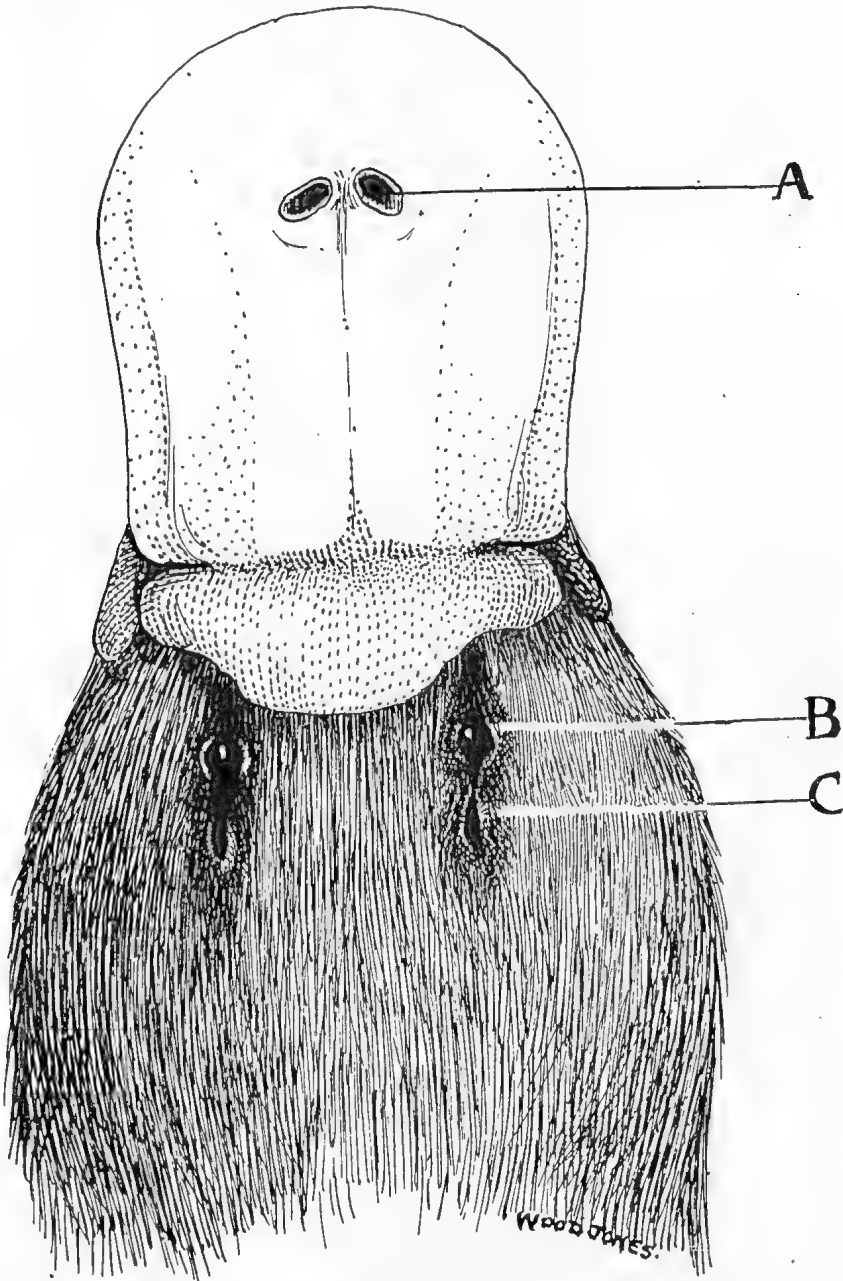


FIGURE 26.—Head of *Ornithorhynchus* seen from above. A, The nostrils, B, eyes, C, ears.
Natural size.

The lower (or mandibular) portion of the muzzle is covered by skin similar in texture to that of the maxillary portion, but the little pores or pits are arranged more definitely in a linear series. From the lower jaw, as from the upper, a folded back portion, like the turned back cuff of a sleeve, overlaps the fur-covered throat. (See Figure 27.)

The tail, in conformity with all the other modifications of the animal, is flattened from above downwards, and it is slightly rounded at its free extremity. (See Figure 28.) Hair, coarse in texture, and of the same dark-brown colour as that covering the rest of the dorsal surface of the animal, clothes its upper surface. In young animals, hair, which is pale in colour, is also present on the under surface. In the adult, however, the lower surface is generally partly denuded of hair, doubtless by reason of the rubbing of the tail against the earth, as the animal trails it behind in the act of walking.

On general lines, the form of the tail resembles that seen in the Beaver; and this form is, in both animals, an adaptation to surface swimming and rapid diving. It has nothing whatever to do (either in the Platypus or the Beaver) with any

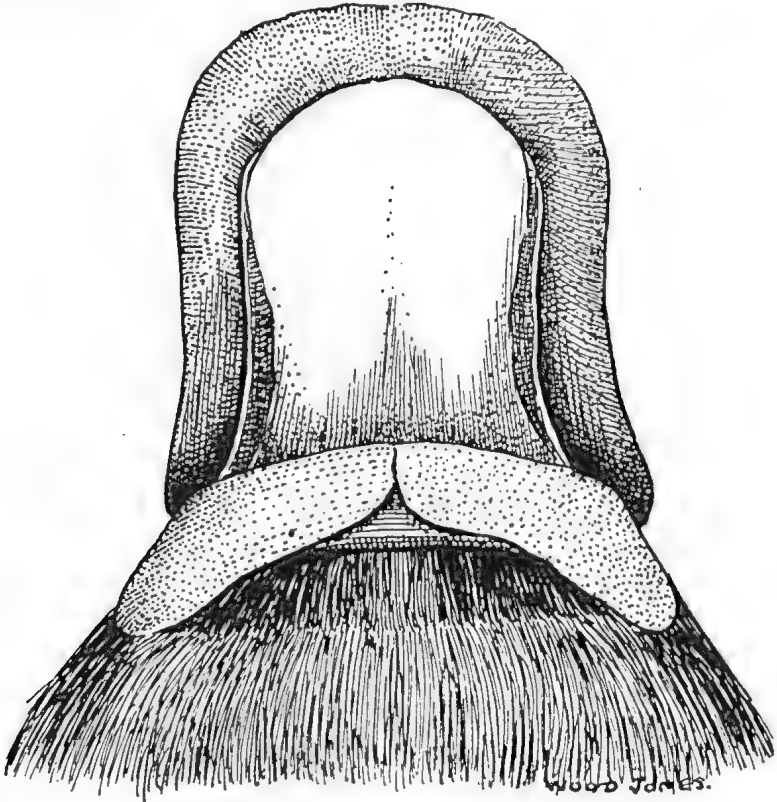


FIGURE 27.—The muzzle of *Ornithorhynchus* seen from below. Natural size.

supposed habit of puddling clay or flattening down the floor of its burrow or nesting chamber. When Beavers are alarmed they suddenly smack the water with their flat tails and dive beneath the surface. The loud sound made by the smack of the diving Beaver acts as a warning note to other Beavers in the neighborhood, and it is probable that the same warning note is produced by the Platypus. The animal has several times been described as making a sound as it dives.

The eye is very small, and is situated just behind the back-turned shield portion of the naked skin of the upper jaw. (See Figure 26.) An indistinctly specialised margin of the surrounding hair forms the eyelashes, which are not well specialised as such. The eye is situated in the anterior end of a furrow, which grooves the lateral and dorsal aspect of the face area in the young animal. In the posterior end of the furrow is situated the external opening of the ear. (See Figure 29.)

In the dried skin and the stuffed specimen too much of this furrow is apt to be allotted to the eye, and so in illustrations drawn from museum specimens the eye is often represented far too large. The eye is deeply situated. It is directed considerably more upwards than is usual in Mammals, even when they are adapted to an aquatic life. The iris is dark-brown, and in life the eye is said to be remarkably bright.

The opening for the ear occupies more of the facial furrow than does the eye. There is no sort of external ear or auricle projecting from the side of the head, but the orifice can be opened and shut at will in the living animal.

The nostrils are situated dorsally and close to the mid-line of the fore part of the muzzle. Their openings are oval in outline, with the long axis directed across the muzzle, but placed somewhat obliquely.

The calcaneal spur of the male is horn coloured, and recurved after the manner of the spur in a game cock. It is movable, and is directed backwards and inwards.

The powerfully built and webbed manus is a very remarkable structure, for the webbing does not consist in a mere membrane joining the adjacent digits together, but it is carried beyond the extremities of the nails by a series of leathery extensions which prolong the line of the digits. (See Figure 30.) This extension is capable of being folded back, so that the tips of the nails are exposed beyond the edge of the web. Strong nails are present on all five digits, and when the web is spread their tips are far outstripped by the free edge of the membrane. The typical digital formula is $4 > 3 > 2 > 5 > 1$.

The pes is less highly specialised. Hair extends almost to the ends of the digits, and the webbing is not carried beyond the roots of the nails. Beneath the first digit a prolongation of the membrane, similar to that seen in the manus, is present. (See Figure 31.) The sharp nails are all curved with their points directed towards the fifth toe. The digital formula, when the toes are ranged in the axis of the limb, is $4 > 5 = 3 > 2 > 1$; but in the position in which the foot is habitually carried, all the toes are deflected from the axis of the limb.

It is well known that the *Platypus* starts its life with calcified teeth, and that these are subsequently replaced by the horny plates which subserve the function

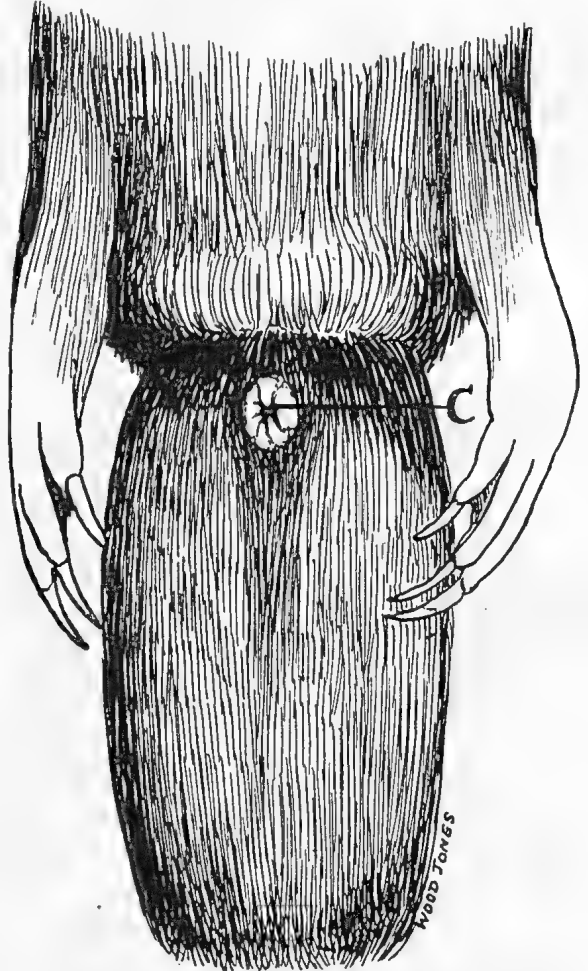


FIGURE 28.—Hind end of *Ornithorhynchus*, to show the tail and the opening of the cloaca (C). From the ventral aspect. Half natural size.

of teeth in the adult and aged. The calcified teeth are very irregular and rudimentary structures. Those of the lower jaw, illustrated in Figure 32, show subdivision into three dental elements upon each side; but all three elements are fused together into a common calcified mass. This common dental mass, unlike true functional teeth, is extremely brittle in its composition. Upon each side of each jaw the dental mass is supported upon a flattened or slightly depressed area of bone.

At an earlier stage the three fused masses are separate rudimentary teeth; and at a later stage their site is taken by the horny plates, of which there are two in each side of each jaw.

The strange continuation of the jaws in the curiously flattened beak naturally leads to the formation of a very peculiar mouth cavity. Like all animals which have to take a large quantity of food into the mouth in a short time—and in this case because the gathering of food is done under water—cheek pouches are developed.

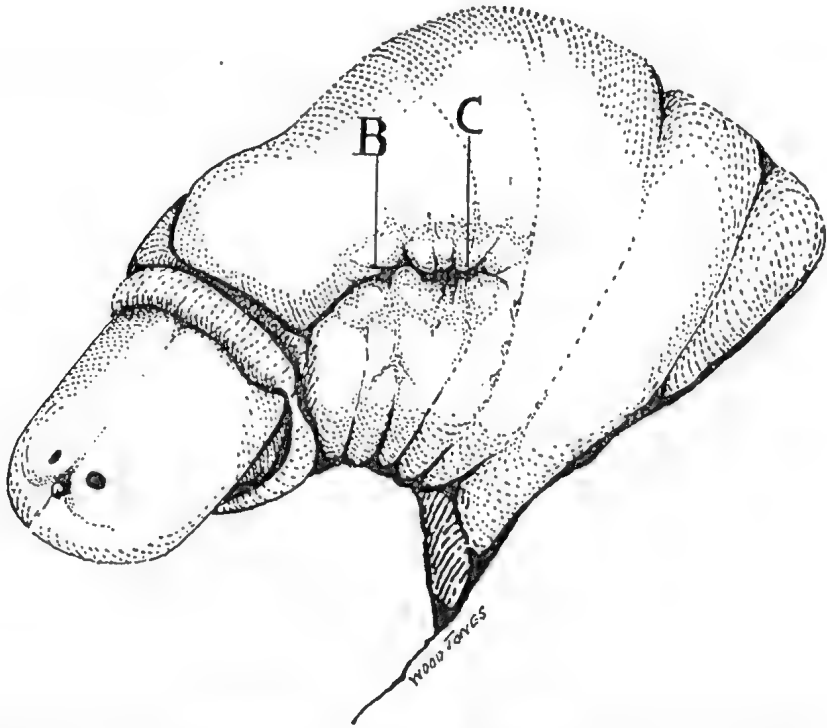


FIGURE 29.—Head of a naked nestling of *Ornithorhynchus*, to show the depression into which the eye and the ear open at B and C. Twice natural size.

The flattened fore part of the mouth, therefore, leads into two spacious pockets, into which the food is shovelled as the animal nuzzles about in the mud at the bottom of the creek. The curious structure of the margins of the lower jaw, and the form of the tongue, are shown at Figure 33, and it is somewhat important to realise the nature of this very curious structure, since it cannot be passed over when the question of the diet is under discussion.

There is a fairly well marked difference in the size of the male and female, the male always being the larger animal. The actual figures given by different authorities show a considerable range of variation, but it must be remembered that the skinned, or stuffed, specimen is always considerably stretched, and that,

in some cases, the larger records are probably made from such material. The specimen figured, which is a female from Victoria, is 485 mm. from the tip of the muzzle to the tip of the tail; the head and body measuring 365 mm. and the tail 120 mm. Other records are as follows:—

	Males.		Females.
	Total Length.		Total Length.
Bennett, fresh specimens	475–500 mm.	..	450–475 mm.
British Museum spirit specimens	563 mm.	..	442 mm.
Ogilby	600 mm.	..	475 mm.

Apparently before the fur of the Platypus was in much demand, and the animal had therefore not attracted to itself the undesirable attentions of the fur hunter, it was by no means strictly confined to darkness, or even dusk, for its main activities. Most of the earlier writers dwell upon the frequency with which it was seen floating upon the surface of the water in the early morning, or even during full daylight; and where it still remains wholly unmolested it evidently retains this diurnal activity.

It is from the accounts of observations upon the living wild animal, and the records of his short-lived captives, by Dr. George Bennett that almost all the current literature of the habits of *Ornithorhynchus* is taken.

These observations were

made, over a series of years, nearly three generations ago. Between Dr. Bennett's time and the immediate present, there has been a long gap in the continuity of the story of our increasing knowledge of the natural history of the Platypus. Quite recently Mr. Burrell, by his observations upon wild animals, and on those he has succeeded in keeping in captivity, has added greatly to our knowledge of all the details of the economy of the animal. Many of these observations are incorporated here. Unlike *Echidna*, the obscurely living Platypus has not, until lately, been much studied whilst living in confinement, for the problem of keeping the animal in captivity successfully has only recently been solved.

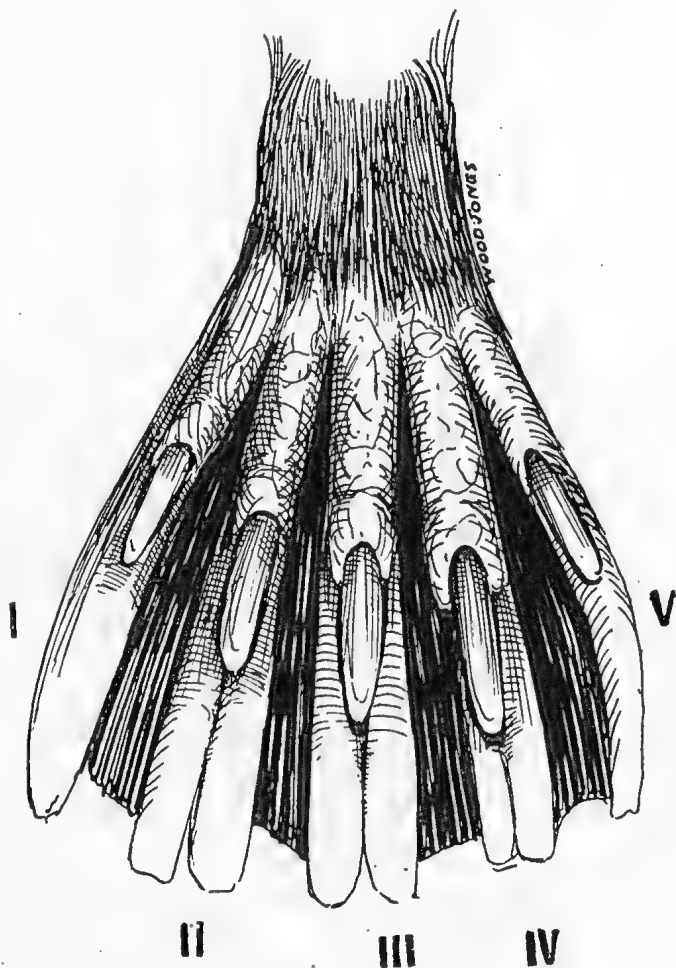


FIGURE 30.—Left manus of *Ornithorhynchus*. Seen from the dorsal surface. Natural size.

The *Ornithorhynchus*, as its structure would lead us to suppose, is a thoroughly aquatic animal, swimming on the surface, diving, and paddling about the bottom of pools with wonderful facility. It is extremely shy, and the first white men who ever saw it noted the readiness with which it took alarm when approached. Its warning sense, be it visual, auditory, or tactile, is wonderfully acute, and when floating on the surface of the water it soon becomes aware of the presence of danger, and dives to safety below. What may be the actual sensory channels by which the Platypus is kept informed of its surroundings, is a point very difficult to determine. That the whole of the soft skin of the beak is a highly important sense organ, is quite definite. The minute structure of the tactile organs in the skin,



FIGURE 31.—Right pes of *Ornithorhynchus*. Seen from the dorsal surface. Natural size.

and their connections with the nerves, tell us this; and so do the observations of Bennett—"if the mandibles were touched they darted away immediately, those parts appearing to be remarkably sensitive." Although the eye of the living animal is said to be brilliant, it is small and deep set, and so situated that its range of vision must be very limited. In any case, one would not expect the sense of vision to be remarkably acute in an animal which spends so much of its time in a dark burrow, or at the bottom of the water.

The sense of hearing is evidently very keen, and there is apparently some perception which enables the burrowing animal to recognise the proximity of another tunnel, and so to avoid breaking into it. A great deal more observation upon the living animal is necessary in order to determine the value of the several sensory channels; and, at present, it can only be confessed that it is impossible to determine what factor in the life of the animal can possibly have produced so comparatively large a brain. A brain, moreover, which, though built upon a lowly plan, possesses so great a share of specialised cerebral cortex, or grey matter.

The Platypus makes its home in the deep pools of rivers and creeks, preferring places where the banks are fairly steep, and where reeds border the edges of the stream. It is surprising how small a stream of water may be the home of quite a considerable colony. In the bank a nesting burrow, of somewhat variable form, is constructed. In length these burrows vary from 20ft. to 50ft., and they commonly run an erratic course into the bank. The burrow twists and turns about; but Mr. Burrell has made the interesting observation that, no matter how the tunnel may cross and recross its own track, the burrowing animal evidently knows when it is approaching a previously excavated portion. More than that, the animal

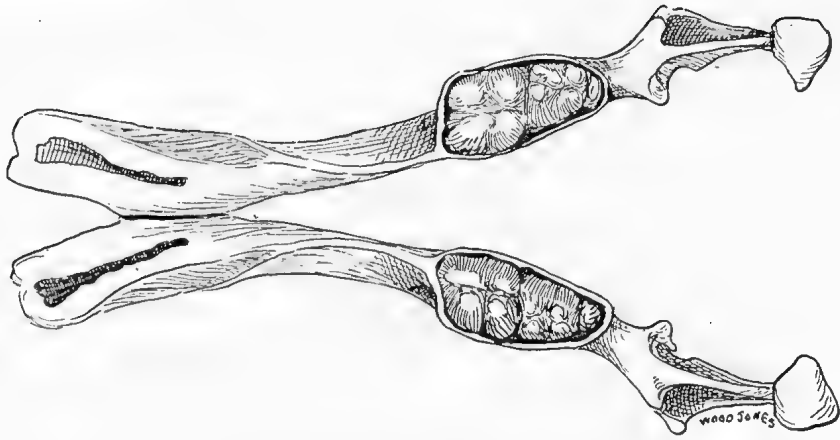


FIGURE 32.—The lower jaw of *Ornithorhynchus*. From a specimen in which the calcified teeth are still present. Natural size.

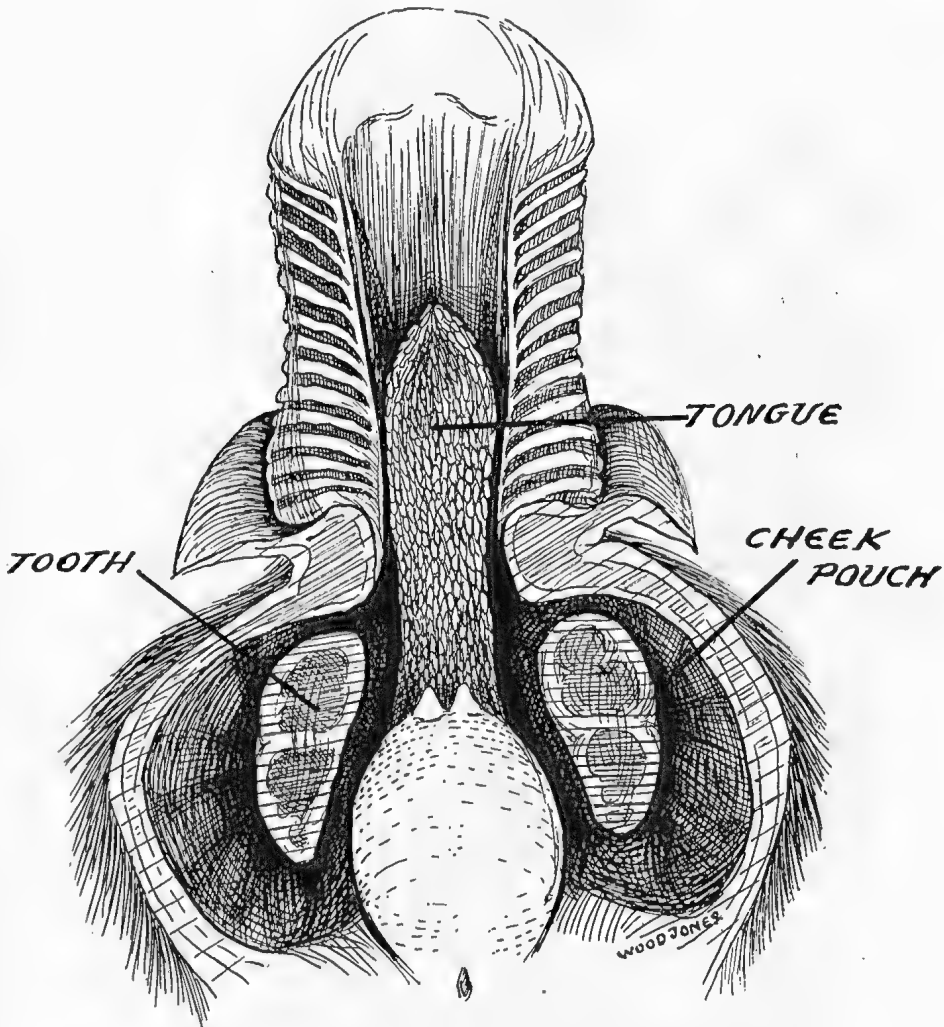


FIGURE 33.—The lower jaw of *Ornithorhynchus*. The drawing is made from a specimen prepared by slicing off the lower jaw by cutting through the cheeks. It shows the peculiar structure of the lower jaw, the tongue and the teeth, which in this specimen are worn down and largely replaced by horny matter.

obviously avoids the already existing burrows of water rats, or rabbits ; for, when it is tunnelling in their vicinity, it alters its course in order to avoid them.

The entrance to the burrow is shaped like a low archway. It fits the form of the burrowing animal, and so is not rounded in outline like the burrows of the rabbit and the water rat. The nesting burrows are specially constructed by the females, and they contain, as a rule, numerous short, blind, side tracks, as well as a large oval nesting chamber in which a collection of leaves and dry grass constitutes the actual nest.

After the young are old enough to shift for themselves these nesting burrows are abandoned, and the shelter burrows used by non-nesting individuals are less

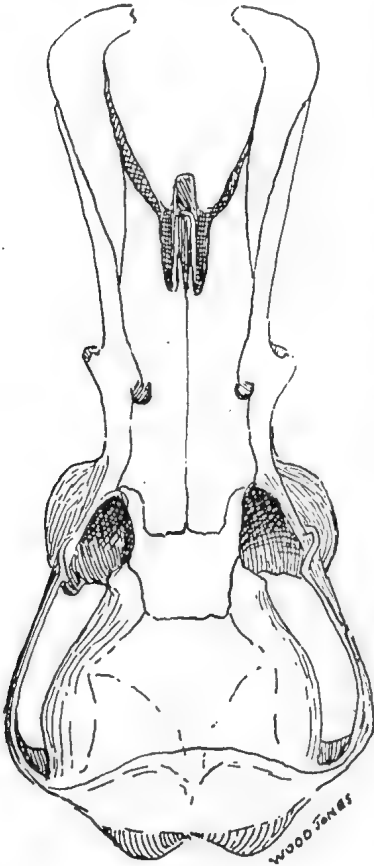


FIGURE 34.—Skull of *Ornithorhynchus*. Seen from above. Natural size.

elaborate in their construction. It is obviously important that an animal which spends so much of its time paddling in the water, or climbing in and out of an earth-lined burrow, should perform some rather elaborate toilet of its fur. Dr. Bennett noted that the first signs of ill-health in his captive specimens showed itself in the neglect of the toilet, and the consequent dirty and bedraggled appearance of the animal. He made frequent note of the care with which they cleaned themselves; and scratched and combed their fur, and wherever he describes how this process was actually carried out he writes of them "scratching themselves with the hind claws." He also notes the difficulties encountered by an animal which was tethered by one hind leg. The scratching is obviously an almost constant employment of the animal, and it is carried out studiously before it enters its burrow, as well as when it lies in its nest rolled up in a ball. Mr. Burrell has also witnessed the process, and describes the animal as squatting "tripod fashion on its haunches" and scratching with its "soft rubber-like hands." From the point of view of adaptations the pes

would seem most fitted to be the main toilet member, but it is possible that both manus and pes are used in the toilet of the fur, as is the case with several of the Marsupials. Bennett also noted that the beak was used to preen the fur "as a duck would clean its feathers."

Unlike *Echidna*, *Ornithorhynchus* is evidently a distinctly vocal animal. Bennett makes frequent reference to his captives growling when disturbed; the growling was, however, no prelude to any offensive on the part of the animal. The same observer also noted that his young animals "uttered a squeaking noise," while of the adult pair he said, "they make a peculiar shrill whistling noise." In both cases the sound was made by one member of the pair, and was recognised and answered by the other.

In most accounts of the habits of the animal great stress is laid on shell fish as forming the basis of the diet, and Semon, in 1899, gave it as his opinion that "the principal food of this animal consisted of a hard-shelled mussel (*Corbicula nepeanensis*, Lesson)."

It has also been suggested that certain water plants are of importance as an article of diet. Bennett, however, never found any vegetable debris in the intestinal canals of the many animals he examined. On the other hand, he records a successful experiment of feeding captive specimens on fresh water mussels, but the mussels were broken up before they were given to the animals. These specimens lived 14 days, and died, in good condition, as the result of an accident. It is commonly said that the peculiar teeth and the curious jaw of *Ornithorhynchus* are developed in response to a diet of shellfish; but it is difficult to see any adaptation to such a diet in any part of the masticatory apparatus which is figured at Fig. 33. Bennett also records the successful feeding of the animal on worms, and includes in its dietary water insects and river shrimps. He fed his captives on bread soaked in water, chopped eggs, and minced meat; but such a diet was obviously not satisfactory, and he suggested that worms and fresh water crustacea would form a suitable diet. Judging from the formation of the parts connected with the ingestion of food, this suggestion is probably correct, and the common river shrimps may be regarded as the staple article of diet.

The Platypus at the present time is distinctly an eastern Australian and a Tasmanian animal, and Bennett did not believe that it existed in South Australia. Its inclusion in the fauna of South Australia is, however, quite correct even at the present day. From some of its old haunts it has disappeared. Nevertheless, it still occurs within the limits of our State, and from its unobtrusive habits it is possible that it may even linger in some places where its presence has escaped notice.

SUB-CLASS II.—DIDELPHIA.

MARSUPIALIA OR METATHERIA.

Unlike the first Mammalian Sub-class (Monodelphia), the Didelphian division contains a varied assortment of animals of widely differing external type, and of numerous species. All these species are bound together by the possession of certain common features which have already been defined (pp. 16-18). These precise diagnostic features will be more fully explained here, and the general characteristics of the Sub-class will be discussed.

Dealing first with the external characters, it may be noticed that the hairy covering varies from the coarse hispid hair of the Short-nosed Bandicoots (*Isoodon*), and the Banded Ant-eater (*Myrmecobius*), to the woolly fur of the Koala (*Phascolarctus*), the silky hair of the Marsupial Mole (*Notoryctes*), and the wonderful chinchilla-like coat of the Rabbit Bandicoot (*Thalacomys*). The great majority of the marsupials are self-coloured, and if there be any variety in the colouration of a self-coloured animal it is usually displayed in the terminal portion of the tail. The tip of the tail may be darker than the coat colour (*Chaetocercus cristicanda*, *Phascogale penicillata*, etc., see Figs. 60 and 63), or paler than the coat colour (*Thalacomys lagotis*, *Pseudochirus peregrinus*, etc.).

When the coat displays a definite pattern, a very curious uniformity is seen throughout the whole of the Didelphia; for what may be termed loin banding, or a barred flank, is the predominant marking throughout the entire series. This loin banding is seen in such varied forms as the Tasmanian Tiger (*Thylacinus*), at times in the Tasmanian Devil (*Sarcophilus*), in the Banded Ant-eater (*Myrmecobius*), and in the Striped Bandicoots (*Perameles fasciata*, *P. gunni*, and *P. bougainvillei*), as well as in the Rabbit Bandicoot (*Thalacomys*). The same loin band again occurs in the Kangaroo Rats (*Aepyprymnus*), in the Hare Wallabies (*Lagostrophus*), and in numerous Wallabies and Kangaroos (*Onychogale*, *Petrogale*, and *Macropus*). Loin banding is probably a partial expression of the uniform body banding seen, for example, in such Monodelphia as the Zebras; but it is curious that, whereas in the Monodelphia a shoulder bar becomes the most permanent partial expression of the general body banding; in the Didelphia the loin band becomes the elected survival (see Figure 79). Another very curious feature of the banded flank is that it is by no means uncommon to have a unilateral slip in the pattern, and instead of a pale bar, followed by a dark bar, running as continuous bands around the girth of the animal's body, a pale bar on the one side becomes continuous with a dark bar upon the opposite side. This slip of pattern is often present in *Thylacinus*, and is not infrequent in *Myrmecobius*; it is also a well known phenomenon in the caudal banding of many of the Reptiles.

The coat pattern which ranks next in order of frequency to the loin banding, and which is often combined with it, is a dark stripe running from the snout through the region of the eye and cheek towards the ear. This cheek stripe is present in a very large number of marsupials of all classes. The other dominant constituent of coat pattern is a mid dorsal stripe, which is seen in several Opossums and Wallabies. Apart from the loin bars, the cheek stripe, and the dorsal stripe, there is the very irregular type of spotting, which is confined to the Native Cats (*Dasyurus*), and the curious piebald blotching seen only in the Cuscuses (*Phalanger*) of New Guinea and the neighbouring islands.

No Australian marsupial adds to the gaiety of its coat pattern by the display of naked and pigmented skin, which is so marked a feature of certain monodelphian groups; nor are any of them remarkable for the brilliant hues of their hairy covering.

Secondary sexual characters are, as a rule, by no means well marked. In most cases the male and the female are exactly alike. Among the carnivorous species, the female tends to be somewhat larger than the male; and in certain kangaroos the sexes are differentiated by coat colour; but no such secondary sexual distinctions are met with in the Didelphia as are commonly displayed among the Monodelphia.

The size to which any particular species of marsupial grows is subject to rather wide variation; and fully adult specimens of a species may vary considerably in their general proportions. This strange phenomenon is particularly marked in those species which inhabit the more arid regions of the Centre; and here it is probably related to the very varying nature of the country during good or bad seasons: the animals being larger when living through a succession of good seasons.

One curious feature which occurs with remarkable frequency among the Didelphia is the presence of fat tails; a condition in which the basal portion of the tail is

swollen or incrassated. This strange phenomenon is seen for example in *Phascogale macdonnellensis*, in *Chaetocercus cristicauda*, and in *Sminthopsis larapinta*, and *S. crassicaudata*, which latter is known as the Fat-tailed Pouched Mouse. (See Figure 68). The degree of thickening in the base of the tail differs somewhat remarkably in different individuals of the same species; and it is possible that the accumulation of fat, and its subsequent diminution, is seasonal in its fluctuations.

The possession of an incrassated tail is no distinction of the marsupials however, for a monodelphian rat (*Conilurus pedunculatus*), discovered in the Centre by the Horn Expedition, and described by Waite, shows the same peculiarity. In this rat the thickening of the tail appears to be rather in the skin than in the sub-cutaneous tissues.

Moreover, there is a strange tendency for the same feature to appear among the Australian lizards. Of the Geckos we may notice *Nephurus laevis* and *Gymnodactylus milii* as outstanding examples of fat-tailed reptiles; and of the typical lizards the common Sleepy Lizard (*Trachysaurus rugosus*) shows the same condition.

In all probability the factor which produces this peculiar type of tail is a physiological one demanded by the conditions of life in the Australian environment. The base of the tail is probably a store house for fat laid up in a good season for use during those lean times to which all life is subjected in the more arid parts of the country.

Apart altogether from the condition of basal incrassation, in which the swollen portion tapers both towards the body and towards the tip of the tail; there is a much more generalised phenomenon of a thickened tail base. This condition may best be described by saying that the body tapers more gradually to the tail than is usual, and the line of demarkation between the hind end of the body and the base of the tail is less sharply defined than in the higher Mammals. The state of affairs is easily realised by looking at pictures of a dog and of the dog-like *Thylacinus*. (See Figure 78). In the dog, the tail is a sharply differentiated appendage of the body, there is no doubt as to where the body ends and the tail begins; but in *Thylacinus* the tail is the continuation of the body—it is the drawn-out hinder end of the animal.

Another curious point in connection with the same phenomenon is the fact that in very many marsupials the basal third or so of the tail is clothed by hair of the same colour and texture as that of the body, the specialised hairs of the tail only appearing some distance down the tail. This feature is conspicuous in *Phascogale penicillata* illustrated at Figure 60.

These two characteristics are obviously associated, and both are probably the expression of a very primitive state of affairs. The tail, in its primitive condition, is the elongated hind end of the body; in its final mammalian state it is an appendage, which is put to various functional uses. To some it may seem absurd to liken the condition seen in the "Pouched Wolf" to that so familiar in the common lizards, but probably both are expressions of the same primitive phase of the caudal end of the body of the primitive land-living Vertebrates.

Another peculiarity of the tail is evinced in the readiness with which it becomes broken off and lost. The Pig-footed Bandicoot was originally named *ecaudatus*

under the belief that it had no tail, for the first specimen obtained was tailless ; and in some places a Short-nosed Bandicoot (*Isoodon*) possessing a whole tail is a rarity.

It is of interest to note that many marsupials, in moments of heightened vitality, express some physiological state of well-being by a rapid vibration of the tail. The movement is expressed as a quiver which runs the length of the tail ; it is altogether different from a shaking, or wagging of the tail ; and it is exactly similar to the movement which may often be seen in the tail of a lizard about to seize some insect upon which its whole attention is focussed. This peculiar movement of the tail is very commonly seen when some of the highly carnivorous Pouched Mice (such as *Chaetocercus cristicauda*) are about to seize upon a victim, and the same thing may be witnessed any day when a kangaroo, in full contentment, is sitting in the sun.

Prehensile tails are carried to a high degree of perfection in the Ring-tailed Opossums (*Pseudochirus*), and are less well developed in many other arboreal types. Some of the Rat-kangaroos (*Bettongia*) possess the distinction of being the only thoroughly terrestrial animals which have typically prehensile tails. A dorsal crest of the tail is a feature which is present in some rather widely separated species ; and a remarkable terminal spur, or " nail," occurs in certain Wallabies (*Onychogale*), as well as in the Rabbit Bandicoots (*Thalacomys*).

The ears of a great many species of marsupials are large, and are commonly capable of being folded when the animal is asleep. The method of folding differs widely in different species. The sensory vibrissae of the face, and of other parts of the body, are, as a rule, particularly well developed ; and the actual condition present will be included in the description of the individual species.

As a general rule, it may be said that the Didelphia are but little gifted with the power of vocalisation. Compared with the Monodelphia they are a notably silent group of animals. Even such as possess loud or striking voices reserve the display of their vocal accomplishments for very definite and, maybe, for very infrequent occasions. It is a matter of common knowledge that the power of producing sound, and the capacity of appreciating it, are usually, and naturally, combined in any animal. We would not expect that an animal that could produce a wide range of vocal sounds would itself be unable to appreciate such a range of sounds.

A vocal animal we would expect to be one in whose life the sense of hearing played a well marked, if not indeed a dominant part. Conversely, it is likely that among animals which are predominantly silent, auditory impressions will probably be subordinate in importance to those of sight, or smell, or some other guiding sense. For the most part, the voices of marsupials are expressions of resentment, and are brought into play almost entirely during quarrels, or fights. Many marsupials, both carnivorous and herbivorous, are noisy in their internecine struggles for obtaining food, or mates ; but the vegetarians, as a rule, possess the loudest voices, and indulge in the most noisy quarrels.

I believe it is true to say that no marsupial has a call, in the sense so familiar in the higher mammals, when one individual makes a definite vocal call to another individual. Among the Monodelphia the use of the voice as a call from individual to individual is a very wide-spread phenomenon, but if a call is used by any of the

Didelphia its use cannot be at all a frequent, or an easily recognisable, circumstance. We may note in connection with this that there are no pack-hunters among the *Didelphia*: no marsupials which combine for the purpose of obtaining food, or resisting enemies, or of gaining mutual protection during the breeding season. Probably the most efficient individual predatory carnivorous marsupial was exterminated by the pack-hunting methods of combination employed by the less efficiently armed dingo.

Most of the *Didelphia* are nocturnal, or crepuscular, in their activities; and the eyes of many species are adapted for vision in comparative darkness. In the Koala (*Phascolarctus*) the pupil is elongated vertically, but the typical *didelphian* pupil is circular. Eyelashes are, as a rule, well differentiated, reaching their maximum development in the wallabies and kangaroos.

The sense of smell is well developed in most forms, and is beyond doubt the dominant guiding sense in most of the terrestrial and carnivorous forms. Few marsupials possess any distinctive scent appreciable by man, and in no case is their natural odour offensive, as is that of the skunks and polecats among the *Monodelphia*. It is rather a remarkable fact that the *Didelphia* do not sweat; and in order to produce surface cooling most species lick their fur. The kangaroos and wallabies lick their arms; and many of the opossums, in the full heat of summer, moisten the greater part of their bodies with saliva.

No marsupial chews the cud, as do the Ruminants among the *Monodelphia*; but kangaroos and wallabies, as well as bandicoots, and probably some other forms have a curious habit of regurgitating their food. This regurgitation is no sign of ill-health, or of an unsuitable diet. The animal, after a meal, makes a vigorous heaving movement of its chest and abdomen, and the stomach contents, which are forced up into the mouth, appear to be re-swallowed without any further chewing.

The toilet of the coat is, as a rule, an elaborate business; and most marsupials are very particular in the matter of combing and cleansing the fur. In some animals the digits of the pes only are employed in scratching the fur; and in others, both manus and pes are used in toilet operations. The syndactylous condition of the pes is, in all probability, a structural adaptation to the function of performing the toilet of the coat. Further reference will be made to this singular modification in dealing with the section *Syndactyla*; and here we will be content with classing it as a functional adaptation, not a degeneration from disuse, or an instrument for use in climbing, but as a specialised toilet implement, analagous to the enlarged 2nd. pedal digit and claw already noted in *Echidna* (p. 43). The under fur of some of the marsupials is the haunt of certain curious ectoparasites known as *Mallophaga*. These *Mallophaga* constitute the Sub-Order of the Insects distinguished as the Biting-lice; several different species have been described from *Syndactyla* such as kangaroos, wallabies, rat kangaroos, wombats, and bandicoots; but they do not appear to be at all common in the coats of the *Didactyla*.

There is a remarkably uniform tendency running through the whole of the marsupials which expresses itself in the development of the lateral digits and the lateral side of the manus and pes. The middle line digit of the pentadactylous manus and pes is the third digit, and, in the *Monodelphia*, selection usually determines the dominance of this digit. The middle, or third, digit of our hands is longer than its fellows;

and in the horse it becomes the sole remaining member of the original five. In the Didelphia, however, the tendency for specialisation is to select the fourth instead of the third; the central axis of manus and pes being shifted outwards. The remarkably specialised foot of the kangaroo shows the dominance of the fourth digit to perfection; but the same phenomenon is demonstrated in varying degrees of development throughout the whole range of the marsupials.

The fact that so many marsupials are jumping, or saltatory, animals has given rise to many speculations by zoologists; and various explanations for the adoption of a jumping habit have been given. Sir Baldwin Spencer was much struck by the parallel (convergent) development of saltatory habits, and modifications, in the syndactylous kangaroos, the didactylous *Antechinomys*, and the monodelphian *Conilurus* of the arid open spaces of the Centre. He came to the conclusion that "possibly the real advantage in the saltatory method of progression amongst these small forms" (*Antechinomys* and *Conilurus*) "lies in the greater difficulty of pouncing down upon an animal travelling by leaps and bounds rather than in any advantage gained in the way of speed." He supposed that the birds of prey were the factor that had caused the evolution of this peculiar mode of progression. As a matter of fact, it is possible that some far more deeply seated biological factor underlies the development of a jumping habit. Open spaces call forth the development of animals which specialise in rapid movements; and we may say that, no matter what stock they may belong to, some animals which inhabit open spaces will develop a rapid gait, and they will either become cursorial (running), or saltatory (jumping). Now the essential difference between these two gaits is this. In the cursorial method of developing a rapid gait the two hind legs are brought into use alternately; in the saltatory method they are brought into use simultaneously. In the perfected saltatory method of progression the fore limbs are altogether dispensed with as a means of propulsion, and the simultaneous use of the hind limbs is alone relied on.

A kangaroo in slow progression uses its fore feet alternately, and its hind feet simultaneously, and it is a saltatory animal because, when rapidly moving, it lifts its fore feet from the ground, and resorts altogether to the use of its simultaneously acting hind limbs. But a bandicoot also always advances its fore limbs alternately, and its hind limbs simultaneously, in slow progression; but it is not a saltatory animal, for when in full gait it still makes use of its fore limbs in progression, although it uses them simultaneously. The bandicoots, in any gait, seem to have no power to use the hind limbs alternately. They cannot run after the manner of a cursorial animal. They are not saltatory, but apparently they show the physiological basis of a saltatory evolution. A saltatory animal may be said to be one which acquires an aptitude for speed when its motor nervous system demands the performance of simultaneous movements of the hind limbs. A cursorial animal, on the other hand, develops the ability for rapid movement in the presence of alternately moving hind limbs.

Certain anatomical characters of the marsupials need mention, and first it is convenient to notice some of the peculiarities of the skeleton. The marsupial skull is distinguished, as a rule, by the smallness of the portion which lodges the brain, and the large size of the part immediately in front of the cranial cavity, which

accommodates the chambers of the nose. Such an osteological condition we should be prepared to meet from a consideration of the importance of the sense of smell in most marsupials, coupled with the relatively low development of their intelligence. Until direct contrast is made between comparable skulls of *Didelphia* and *Monodelphia*, the disproportion between the cranial and the facial or nasal portions of the skull is often not appreciated.

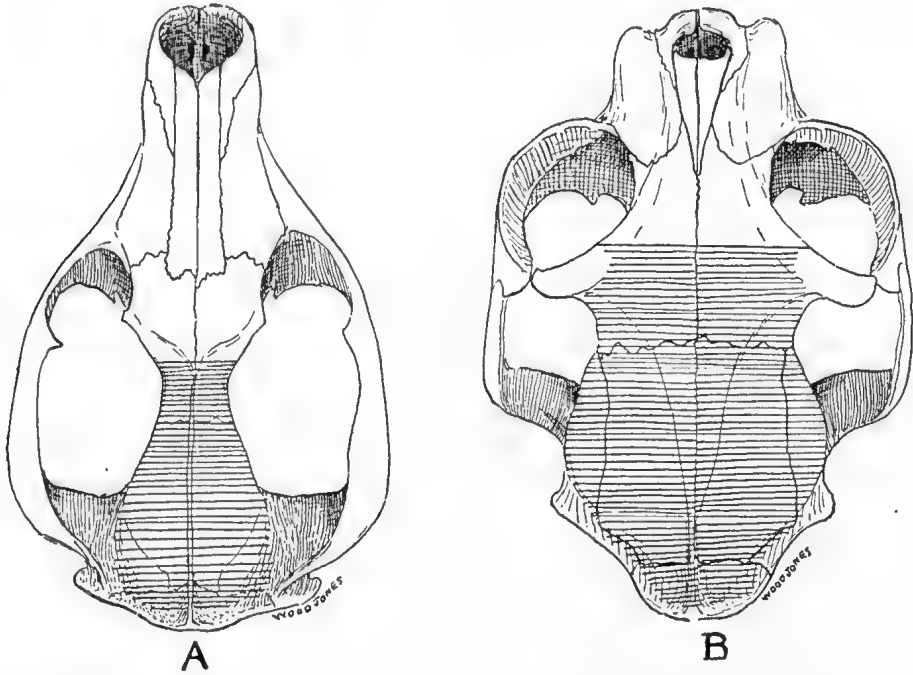


FIGURE 35.—The skulls of A. a Tiger Cat (*Dasyurus*), and B. a Domestic Cat of exactly the same length. The part of the skull which lodges the brain is marked by transverse lines in both cases. Two-thirds natural size.

Figure 35 shows the skulls of the didelphian Tiger Cat (*Dasyurus*) and the monodelphian Domestic Cat. The skulls figured are of exactly the same length. The *Dasyurus* skull shows a series of very perfect adaptations to the end of seizing and killing prey, and to this end it is better equipped than is the Domestic Cat; but as a brain case, in which is stored the organ of the animal's intelligence, the skull of the *Dasyurus* falls very short of the standard of the monodelphian cat. The contrast between these two skulls is a very remarkable one, and the triumph of the intelligent killer over the killing machine is being witnessed all over Australia where didelphian and monodelphian meet.

A very common character of the marsupial skull is the presence of gaps in the bones which form the roof of the mouth. These gaps are known as *palatal vacuities*, and they are so frequently developed as almost to constitute a peculiarity of didelphian osteology. They may be single, double, or multiple; and they may occur at differing sites in the palate. In Figure 36 the very large median gap in the palate of *Thalacomys* is illustrated. The smaller holes seen in the palate, behind the main gap, are those which are enlarged to make the perforations in the palates of many of the kangaroos and wallabies (see also Fig. 7). In most cases, the holes increase in size with the age of the animal; and in the kangaroos and wallabies

the palate is complete in the young animal, and the perforations only appear when it has cut the majority of its teeth. In certain forms, the palate is complete throughout life. Figure 37 shows the palate of *Myrmecobius*, and in this strangely primitive didelphian type the palate is not only imperforate throughout life, but it is of remarkable extent.

The form of the didelphian lower jaw is a matter of some importance, since, by a chance which is not very easy to account for, the lower jaw alone is so commonly preserved in a fossilised condition, when all the other portions of the skeleton of

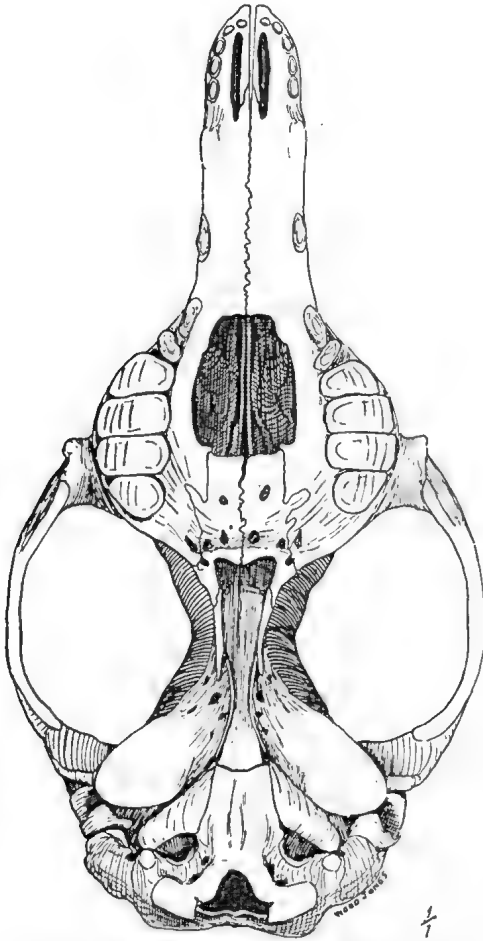


FIGURE 36.—Skull of the Rabbit Bandicoot (*Thalacomys*), drawn from below to show the large gap in the bones forming the palate. Natural size.

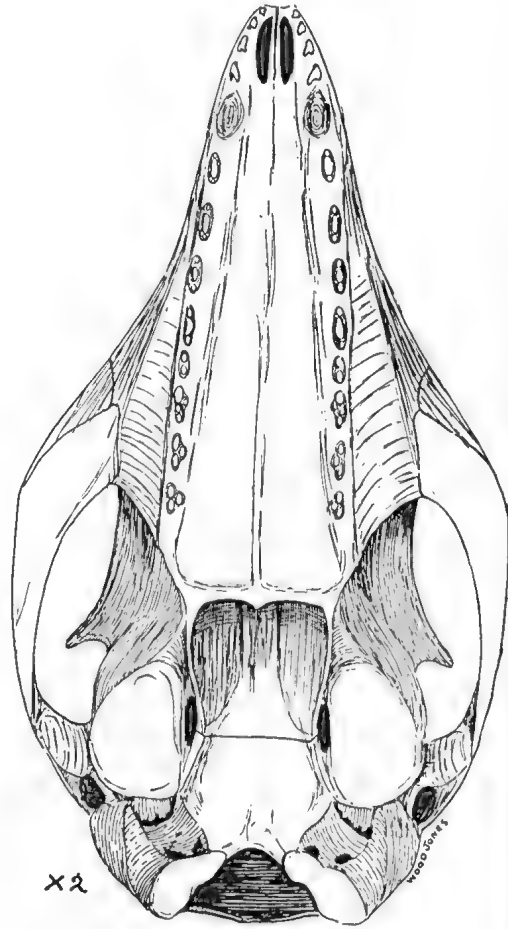


FIGURE 37.—Skull of the Banded Ant-eater (*Myrmecobius*), drawn from below to show the very extensive and complete palate. Twice natural size.

a long extinct animal are lost for ever. It is characteristic of the lower jaw of the existing marsupials that, at the back of the jaw, the lower edge of the bone is bent inwards. This condition is known as inflexion of the angle of the lower jaw; and it is noteworthy that it was the detection of this character, in the fossilised jaws of the oolite formations of Stonesfield, that first caused the great comparative anatomist Cuvier to declare that not only were these jaws mammalian (a view which was opposed by his compatriot De Blainville), but that they belonged to extinct marsupials.

The degree of inbending is but little marked in *Myrmecobius*, but in most species it is very pronounced. The condition is illustrated from the jaw of the Tasmanian Pouched Wolf, which in this respect shows a marked contrast when compared with the, otherwise very similar, jaw of a dog. (See Figure 38).

The separate bones (vertebrae), which compose the backbone in the neck, the back, and the loins, show a great constancy in their number in the marsupials. In all species (as in all typical mammals) there are seven bones in the neck (cervical vertebrae), and in all species there are nineteen in the chest and abdomen (dorso-lumbar vertebrae). In most marsupials thirteen of these dorso-lumbar vertebrae bear ribs (dorsal or thoracic vertebrae), and six are ribless (lumbar vertebrae). The typical marsupial, therefore, has seven joints in the neck, thirteen joints and thirteen ribs in the chest, six joints in the loins, and an indefinite number of joints in the tail.

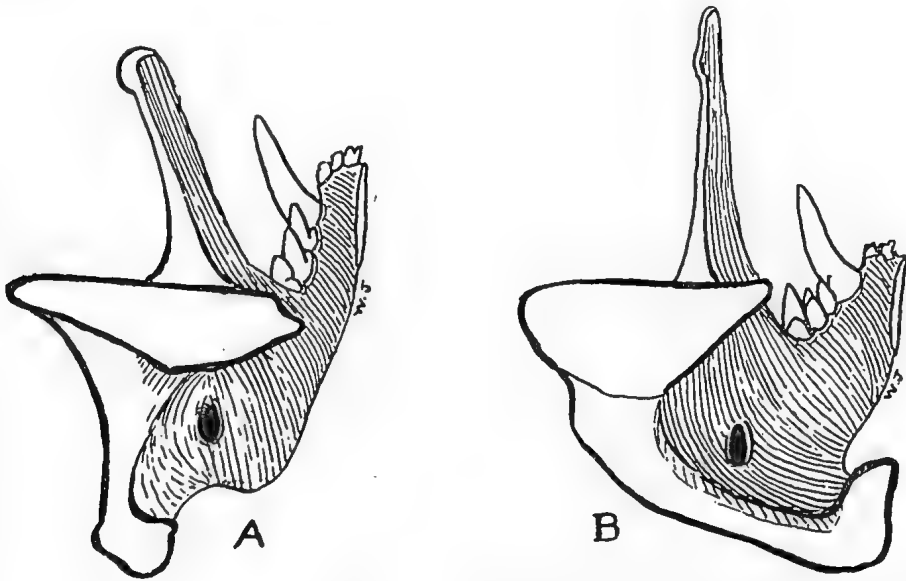


FIGURE 38.—The left halves of the lower jaws of A. a Dingo, and B. a Tasmanian Pouched Wolf (*Thylacinus*). The jaws are seen directly from the back so as to show the manner in which the marsupial lower jaw is bent inwards at its posterior end.

As a marked distinction from the Ornithodelphia, the Didelphia show an universal reduction of the coracoid bone, which element in most species becomes reduced to an inconspicuous knob on the shoulder bone (scapula). In the bandicoots the clavicles also are absent, as they are in many of the Monodelphia, but in all other Didelphia they are present, and usually they are well developed. The clavicles are bones the development of which depends upon function, and the limited nature of the movements of the fore limb in the bandicoots accounts for their failure to develop.

In most Didelphia, but not in all, the lower end of the arm bone (humerus) is traversed, upon its inner side, by a wide hole. This hole, which is known as the *epicondylar foramen*, is a feature which reappears in many of the Monodelphia, and is occasionally present in Man. The *epicondylar foramen* of the kangaroo is shown in Figure 39.

The nature of the epipubic, or so-called "marsupial," bones has been already discussed in dealing with the *Ornithodelphia* (p. 35). These bones are present in all marsupials, with the exception of the Tasmanian Pouched Wolf (*Thylacinus*): in this animal they are represented only by small unossified pieces of fibro-cartilage. In the kangaroos they are relatively small, but are well ossified. (See Figure 40).

The knee cap, knee pan, or patella is not developed in most



FIGURE 39.—Right humerus of a kangaroo. The arrow passes through the epicondylar foramen.

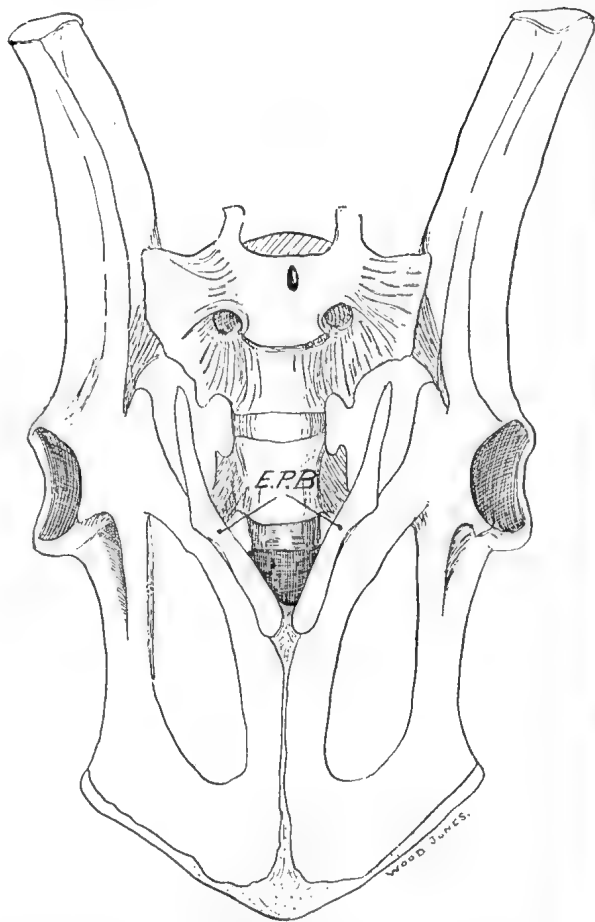


FIGURE 40.—The pelvis of a kangaroo to show the "marsupial" or epipubic bones marked E.P.B.

of the marsupials. In the bandicoots alone is there a well developed and ossified patella. In all the rest of the *Didelphia* there is merely a thickening of the tendon of the muscles of the front of the thigh as this tendon passes over the knee joint. This thickening may be merely a development of fibrous tissue, or it may be cartilaginous, or it may contain a few irregular little masses of bone.

The *Didelphia*, like the *Monodelphia*, possess well developed, and functionally specialised teeth. The range of diet open to the marsupials is as wide as that available for the higher mammals; and, as a natural result, both *Monodelphia* and *Didelphia* show all phases of the modification of their dentitions into definite types for the purpose of eating grass, browsing on herbage, catching, killing, and biting up insects, killing and tearing other animals, and for dealing with those more varied fares known as mixed diets.

There are typical herbivorous and typical carnivorous marsupial dentitions, just as there are grass-eating and flesh-eating dentitions among the higher animals. The dentitions of carnivorous and herbivorous marsupials are markedly different from each other, and the whole of the Order may be divided into two Sub-orders by reference to the prevailing type of dentition. In the carnivorous marsupials, as in the carnivorous Monodelphia, there is a tendency to retain an ample series of small front teeth; whereas, in the herbivorous section, the front teeth are reduced in number but increased in size. The marsupials with the carnivorous type of dentition are therefore termed *polyprotodontia*, and those with the herbivorous type *diprotodontia*; but, as we shall see later, such a classification by dietry is hardly likely to express the true genetic affinities of the animals concerned.

Although the dentition of, say, an insect-eating didelphian will show considerable general convergent resemblance to that of an insect-eating monodelphian, and individual teeth may become strikingly similar; nevertheless the didelphian peculiarities are always noteworthy. In the first place, the teeth of the Didelphia tend to be numerous, and the Banded Ant-eater (*Myrmecobius*) has the distinction of possessing no less than 56 teeth in some instances. Again, no marsupial is distinguished as a toothless or edentulous animal, as are certain of the Monodelphia.

The second peculiarity is that although there are 7 cheek-teeth on each side of each jaw in both Didelphia and Monodelphia, 4 of these teeth are molars, and 3 are premolars in the marsupials; whereas, in the Monodelphia, only 3 molars are developed, the remaining 4 cheek-teeth being premolars. The possession of a fourth molar tooth constitutes a well-marked didelphian peculiarity.

The typical, or ideal dentition of the Didelphia may be summed up in a dental formula written as follows:—I. $\frac{5-5}{4-4}$; C. $\frac{1-1}{1-1}$; PM. $\frac{3-3}{3-3}$; M. $\frac{4-4}{4-4} = 50$.

It must be understood that the typical marsupial formula is an ideal one, from which individual species vary in one direction or another; some have more teeth some have less; and the total may be as few as 22 in the little *Tarsipes* of Western Australia, or as many as 52 or even 56 in *Myrmecobius*.

It is a remarkable fact that, with the single exception of the Wombat, no marsupial has the same number of incisor teeth in the upper and lower jaws. The Wombat has two upper and two lower incisors; but in all other marsupials the upper incisors exceed the lower incisors in number.

The next dental distinction of the marsupials concerns the succession of their teeth. In Man, as in the majority of monodelphian mammals, there are two sets of functional teeth; a set of temporary or deciduous teeth, which is shed as age advances, and is replaced by a set of permanent teeth. In some marsupials, only one set of developed teeth is present throughout the whole of the animal's life; and in no marsupial is more than one tooth upon each side of each jaw replaced by a succeeding tooth when it is shed. We may, therefore, say that there is only one functional member of a deciduous set of teeth developed in the Didelphia. This single tooth is a molar. The replacing tooth is always the hindmost of the premolars, and it replaces the most anterior member of the molar series. This limited succession, or absence of succession, is typical of all marsupials; but in some forms, especially in the kangaroos, there is, combined with the replacement

of the single tooth, a curious shifting of the whole line of the cheek-teeth towards the front of the jaw. The succession, and shifting, make the determination of age, and the diagnosis of the actual teeth present in the jaws, matters of considerable uncertainty. In all accounts of the actual state of the teeth in any of the kangaroos or wallabies great caution is needed in assigning names to the individual teeth. These curious changes may be readily followed by reference to the diagrams (Figures 41-42) drawn from actual stages seen in a series of skulls of the Kangaroo Island Wallaby (*Thyogale eucaeni*). In the young animal represented at Figure 41A five

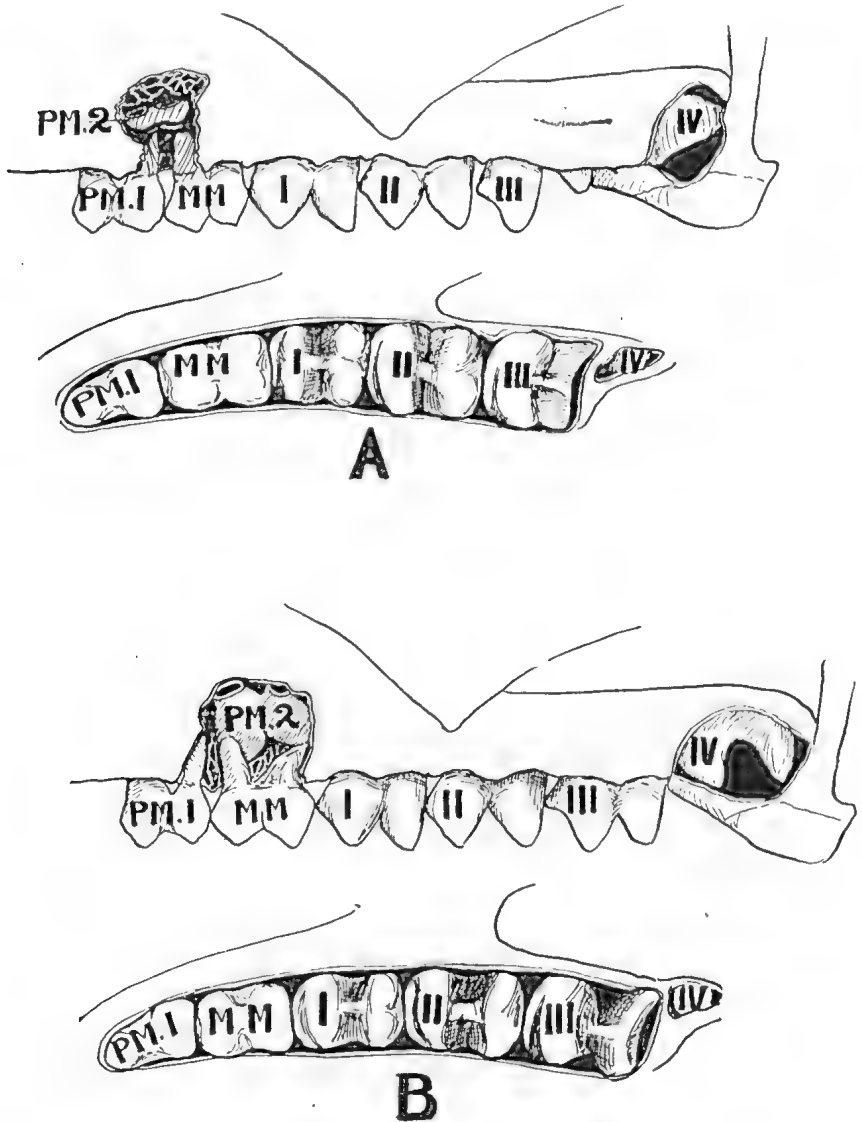


FIGURE 41.—Successive stages in the eruption of the teeth in a wallaby (*Thyogale eucaeni*).

cheek teeth are present. These are, from before backwards, the 1st premolar (PM. 1), the temporary molar (MM), and the 1st, 2nd, and 3rd permanent molars (I., II., & III.). If the bone of the upper jaw be cut away above the temporary molar, the germ of another tooth, the last premolar (PM. 2), will be found developing; and, in the same way, behind the 3rd permanent molar, the germ of the 4th (IV.) will be found buried in the jaw. In the animal represented in the same

figure at B, the same teeth are present in the jaw, but the buried and developing teeth have increased in size.

In the stage shown in Figure 42c, the temporary molar has been shed, and the second premolar has been cut so as to take its place. There are still five cheek-teeth present in the jaw, but they are not the same five as were present in stage A.

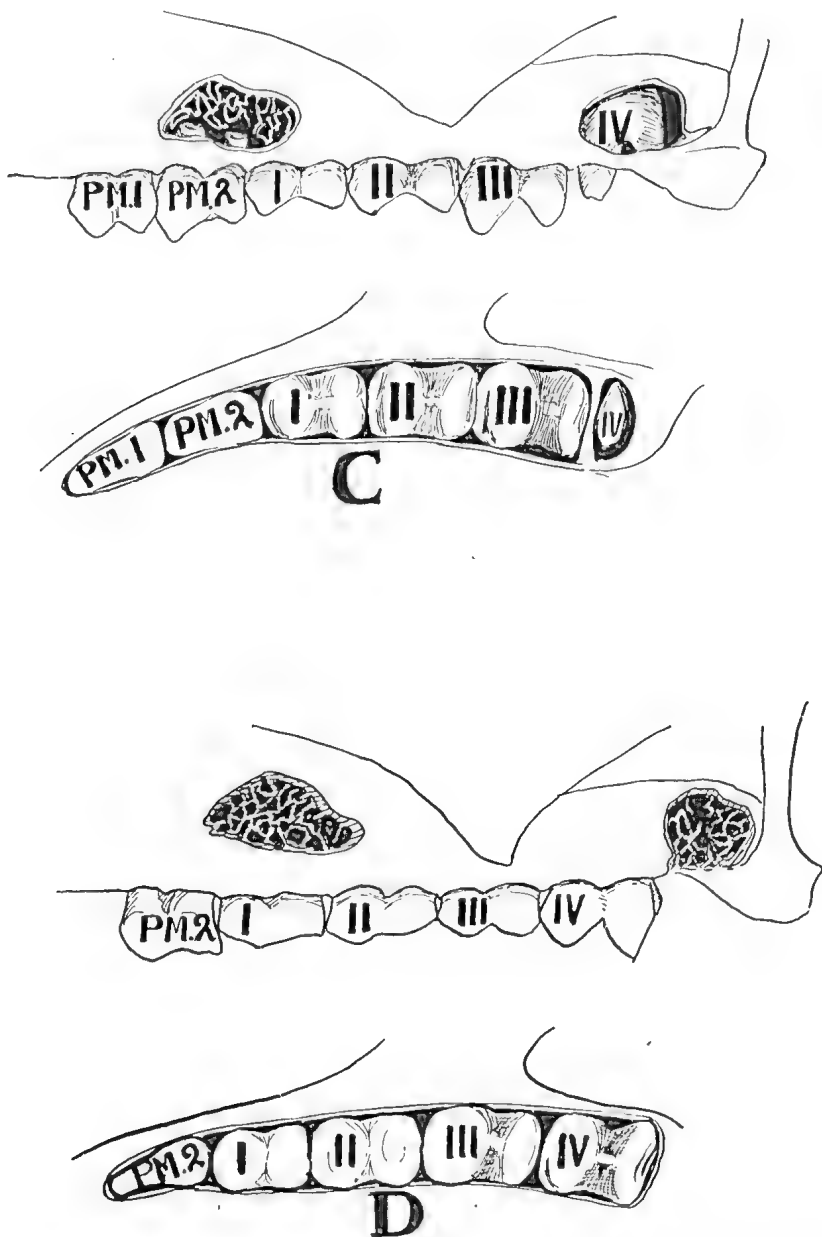


FIGURE 42.—Further stages in the eruption of the teeth in a wallaby (*Thyogale eugenii*).

In D, which represents a still older animal, another series of changes has taken place. First, the anterior premolar has been shed, and the 4th permanent molar has been erupted—there are still five cheek-teeth in the jaw, but these five are not the same as those in A or in C. Nevertheless, the resemblance between stages A

and D is made remarkably close, since the whole line of 5 teeth has shifted forwards, so that the 5 cheek-teeth in D occupy the same relative position in the jaw as did the 5 cheek-teeth in A.

These very curious dental changes render it essential that all statements with regard to the number and kind of teeth present in any given skull should be made with due caution, and it is always better to remove a small flake of bone, and look for the buried teeth, than to make a doubtful diagnosis by merely examining the crowns of the teeth that are cut. In animals older than the stages represented in the figures, the number of the cheek-teeth becomes reduced by the wearing away, and the loss of the foremost members of the series. Aged animals possessing but one molar tooth upon each side of each jaw are occasionally met with; but

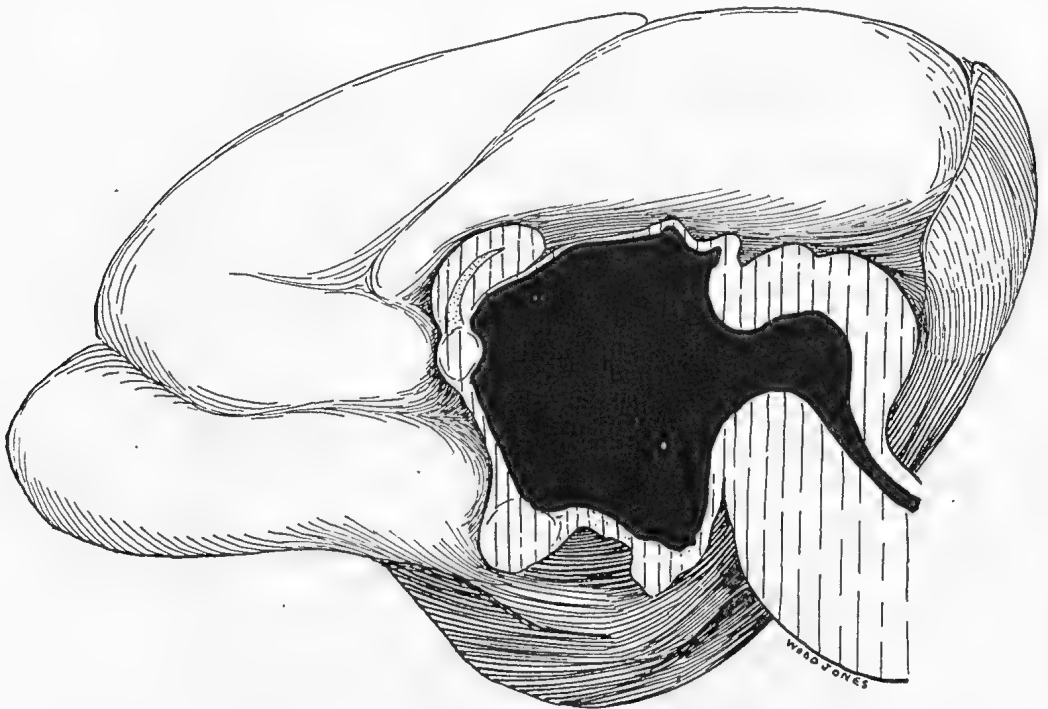


FIGURE 43.—The brain of a wallaby. The brain has been cut into a right and a left half, and the figure shows the right half. The parts cut through in separating it from the left half are marked by vertical lines. The black portion is the central cavity of the brain. This figure should be compared with Figs. 16 and 17. No true corpus callosum is present.

curiously enough this solitary 4th molar continues to move forwards in the jaw; so that the tooth, which was erupted at the extreme hind end of the jaw, ends its career at a site well in front of the root of the zygoma.

Of the more deeply seated distinctions of the *Didelphia* we need only note—as we did in the case of the *Ornithodelphia*—the general condition of the brain, and the peculiar organisation of the reproductive system in the female.

The marsupial brain is small when compared with the size of the animal. We have already noted that in the cranium the brain case is very small relatively to the facial part of the skull. The same fact is made evident when we compare the weight of the brain with the total weight of the body of an adult animal. If we take animals which are very roughly comparable in general bulk, such as a man,

a pig, and a large kangaroo, and weigh the brain and compare it with the weight of the body, we will find that the ratio varies widely. The brain of a man weighs about $1/40$ of his body weight, a pig's about $1/300$, and a kangaroo's no more than $1/800$. In some of the small carnivorous marsupials, however, the brain is considerably more bulky in proportion to the body than it is in the kangaroo.

Not only is the didelphian brain relatively small, but, like the brain of the Ornithodelphia, it lacks the great bond of nerve fibres which unites the right and left halves of the brain together. In Figure 43 the right half of a wallaby's brain is shown, and this figure should be compared with those of the ornithodelphian Platypus (Figure 16) and the monodelphian Cat (Figure 17). It will be noticed that, although the linkage between the two hemispheres is more complete in the wallaby than it is in the platypus, the great monodelphian connecting nerve tract (corpus callosum) is still wanting.

We have already noted that the outstanding peculiarity of the reproductive system of the females, which earned for the Sub-class De Blainville's name Didelphia, is the fact that the oviducts of the right and left sides remain separate from each other in the middle line of the body, and that the uterus is therefore essentially double.

This middle line separation of the right and left oviducts is the outcome of an anatomical arrangement, which makes its appearance at a very early stage of development, and which finds its clearest expression in the fact that the ducts of the kidneys (ureters) pass between the oviducts in the Didelphia; whereas the oviducts pass between the ureters in the Monodelphia. (See Figures 12 and 13). It is the passage of the ureters between the oviducts that prevents the oviducts from meeting in the middle line and fusing to form a single wide-bored median structure.

The condition of the female reproductive system in the Didelphia is somewhat like that which we have already seen in the Ornithodelphia; but in the Didelphia the oviducts have become specialised into three distinct portions. These three parts are known as the Fallopian tube, the uterus, and the vagina; and there is, therefore, a Fallopian tube, a uterus, and a vagina upon each side of the middle line of the body.

In the Ornithodelphia the egg passes down the oviduct, and is expelled from the cloaca as a shelled egg; but it must not be forgotten that this shelled egg has been undergoing development during its passage down the oviduct. It has been deriving nutriment from the maternal tissues; and it contains a considerable embryo at the time of its extrusion. The ornithodelphian egg, once it is extruded, has, by some means or other, to be assisted into the incubatorium in those forms, such as *Echidna*, in which a temporary brooding pouch is developed.

The didelphian eggs, which develop early traces of a shell-membrane reminiscent of the eggs of the Ornithodelphia, come to maturity while still within the oviduct, and they are arrested in their passage to the cloaca. The embryos, hatched in the uterine portion of the oviducts, make, by their embryonic membranes, a connection with the wall of the uterus for the purpose of deriving nourishment for their further development. The connection which the embryonic tissues make with the maternal tissues varies in different members of the Sub-class, but in all cases it constitutes,

physiologically or anatomically, a functional placenta. Since there is no median uterus, provided with a wide-bored median tubular vagina, in which the embryos may grow to maturity, and through which they may be extruded, the didelphian embryos are limited in the length of their stay in the maternal chambers. They are therefore extruded, or born, in a relatively immature condition, not enclosed in egg shells as are the embryos of the Ornithodelphia, but nevertheless considerably undeveloped when comparison is made with the new born young of certain of the Monodelphia.

The immature offspring extruded from the cloaca does exactly as the immature young of the higher animals do—it grasps a nipple with its mouth, and clings to it. In the business of finding, and grasping a nipple, we know very well that the mother assists the young among the Monodelphia, and probably the same thing applies to the Didelphia. The whole process, from extrusion to nipple grasping, among the pouchless didelphians demands no more explanation than does the similar transition of the young monodelphian, in those cases where the young are extruded in a singularly immature condition. In the pouched didelphians the offspring is transferred to the marsupium, where it becomes anchored upon one of the nipples, deriving its nourishment from its mother's milk, as do the new born young of the Monodelphia. When growth has proceeded sufficiently far to enable the young animal to lead a partly independent existence it becomes free of the nipple, but, in pouched forms, continues to live in the pouch, suckling only at intervals, until it is able to shift for itself. Even after pouch life proper is done with, the young animal still suckles after the manner of a monodelphian infant.

In the pouchless forms the young merely hang from the nipples, and are thus dragged about by the mother. Considerably more than a month is spent by the young in this position in certain pouchless forms, and, towards the end of the period of adhesion to the nipples, the young animals present a most remarkable load, which is dragged about by the mother in all her foraging activities. (See Figure 81.) Such are the broad outlines of marsupial reproduction; for the most part they were established nearly a century ago. There would be no need to fill in this outline with further detail but for the fact that, in Australia, the whole question of marsupial reproduction has become surrounded by such a maze of prejudice, misrepresentation, and ignorance that no bald statement of the actual plain facts will suffice.

Before further study may be made of the process of reproduction it is necessary to define with some degree of precision the parts of the internal genital system of the female. There is no doubt that complete ignorance of the anatomy of the reproductive system accounts for the erroneous beliefs that are, from time to time, current. The typical condition, as it is seen in a young female animal that has never been pregnant, is shown diagrammatically in Figure 44. It will be noticed that a narrow tubal portion of the oviduct leads from the ovary to the wider uterine portion, and that from the uterine neck a narrow canal runs backwards close to the middle line, and then bends upon itself to run as a long tube that opens into a chamber situated at the posterior end of the body. The long tube that runs from the uterine neck to the posterior chamber, or uro-genital sinus, is named the vaginal portion of the oviduct. The vaginal portion is divided into two parts; the part that immediately follows the uterine neck and lies towards the middle line of the

body, and the part which runs backwards on each side of the body to the urogenital sinus. These parts are named respectively the median and lateral portions of the vagina. The angle where the median vagina turns to join the lateral vagina is marked as a little recess, which afterwards becomes of the greatest importance, and which is known as the vaginal cul-de-sac. The bend in the lateral vagina, which lies nearest to the head end of the animal is dilated into the form of a capacious thin-walled chamber; this chamber is best named from its structure, as the vaginal caecum; or from its function, as the receptaculum seminis.

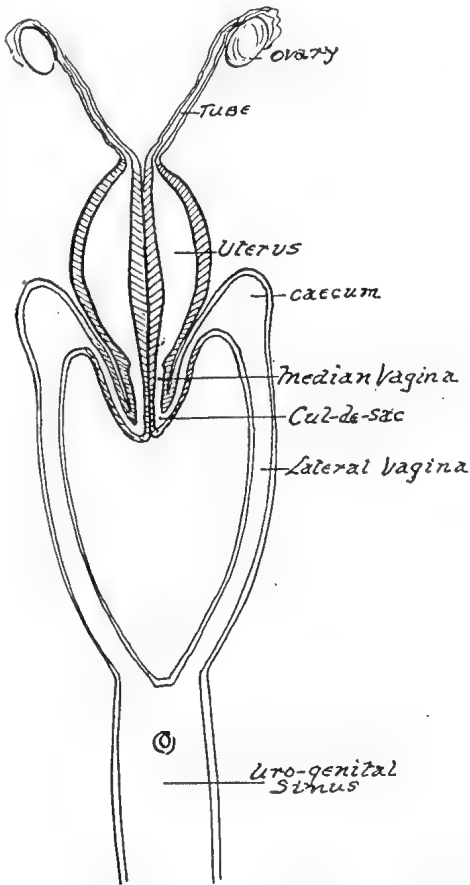


FIGURE 44.—Simple diagram of the reproductive system of a female marsupial. Stage I.

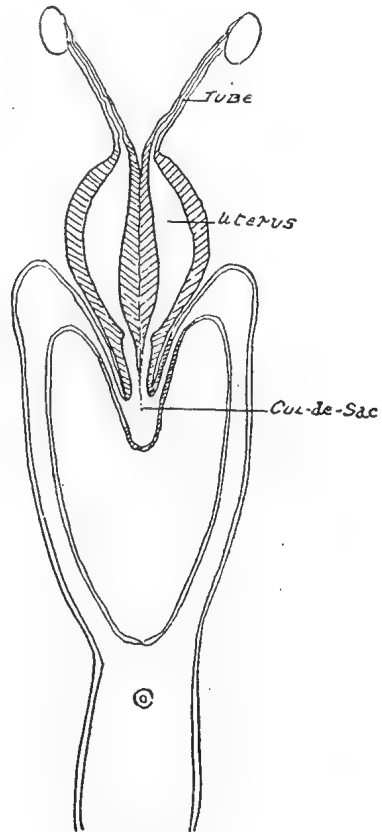


FIGURE 45.—Simple diagram of the reproductive system of a female marsupial, showing advances upon the stage illustrated in figure 44.

It is necessary to point out that the kink in the oviduct which leads to the differentiation of a lateral and a median portion of the vagina, and to the development of the cul-de-sac, is caused by the passage of the mesially situated ureter. (See Figs. 12 and 47).

Some degree of formation of the cul-de-sac may, therefore, be said to be a necessary part of the marsupial anatomy. But the degree of development of the backwardly directed median portions of the vaginae differs greatly in different marsupials. The condition which is represented diagrammatically in Figure 44 shows the state of affairs actually present in the bandicoots, but in many other types advances have been made from this stage. In the first degree of advance the wall

between the two cul-de-sacs is broken down, and a single median vaginal pouch is formed. This stage is illustrated in Figure 45. The median vagina is a process that may be of very different lengths in different species, and in some forms it extends to a blind termination which is almost in contact with the wall of the uro-genital sinus. A long median vaginal canal is typical of the kangaroos and wallabies, whereas a short cul-de-sac is characteristic of the bandicoots.

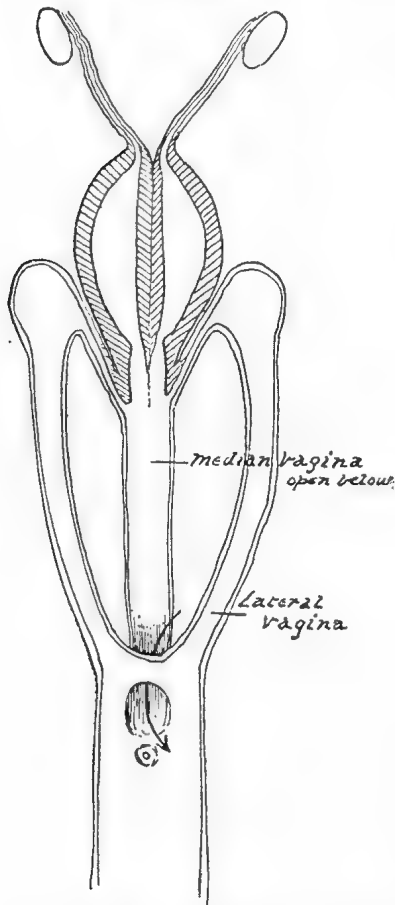


FIGURE 46.—Diagram of the reproductive system of a female marsupial in which the median vagina opens below into the uro-genital sinus.

All the facts with regard to fertilisation are well established. The lateral vaginal canals are the channels by which fertilisation of the eggs, shed from the ovaries, is effected. The vaginal caeca become distended, and function in their capacity as receptacula seminis. The fertilised egg then passes into the uterus, and with the uterine wall makes some degree of placental connection, and enters upon its stages of interuterine development.

The placenta of the bandicoots (*Peramelidæ*) was described with the utmost minuteness by Professor J. P. Hill in 1897, that of the native cats (*Dasyuridæ*) by the same authority in 1900, and the embryonic membranes and uterine connections of other forms have been described and figured by other authors.

The period of utero-gestation varies in different forms, and in all cases it is one which is difficult to determine exactly. As we shall see later, there is evidence that the period is far from constant in some species. Selenka in 1886 concluded, from observations on the American Opossum (*Didelphys*), that the stay in the uterus was barely eight days. Hill studied a very large number of cases of breeding of the Native Cat, and he records that the shortest period from pairing to the birth of the young was a little over eight days. In Owen's

classical case of observation on the kangaroo, and in several other instances of the breeding of kangaroos in captivity, the period has been recorded as being about five weeks.

The actual route for the birth of the young was declared by Sir Everard Home, so long ago as 1795, to be the median vagina. The specimens which Home examined, and from which he drew his conclusions, were certain pregnant uteri of kangaroos, which had been sent to the illustrious John Hunter not long before his death. It is an interesting question, easily asked but impossible to answer, how far Home's assertion that the median vagina was the channel of birth was based on observations already made by Hunter on his specimens.

Hunter had dissected several Australian marsupials, and was fully alive to the

peculiarities of their reproductive history. He said in one of his essays, "I have a great many facts respecting them; yet I am not certain that I am possessed of sufficient information to complete our knowledge of the system of propagation in this class." John Hunter died in 1793; in 1795 Home made the fundamental statement that the lateral vaginae were apparently not the route by which the embryos reached the exterior.

Home's opinion was not accepted by all zoologists, for the simple reason that in many female marsupials that were dissected, the median vagina was present only as a cul-de-sac, or as a longer, but still blind, passage ending somewhere near the wall of the urogenital sinus. It was obvious that, in these females, the only passage from the uteri to the exterior was by way of the lateral vaginae. Yet it was equally certain that in many animals, which had been examined by competent anatomists, the condition was as Home described it in John Hunter's specimens. This condition of a median vagina open to the exterior is illustrated diagrammatically in Figure 46, and by a drawing of an actual dissection in Figure 47. These facts led to considerable controversy, and the next advance in knowledge came in 1881 when J. J. Fletcher and J. J. Lister, working on kangaroos, brought to light the general truth that the median vagina was present in animals that had born young, and that it was absent in the very young female. In 1889 Sir Edward Stirling dissected a female kangaroo in which an embryo was actually passing down the median vagina, and so the route by which birth took place was settled for, at any rate, certain of the Macropodidae. In 1899 Professor J. P. Hill studied the processes of parturition in the bandicoots. In these animals, as we have seen, the median cul-de-sacs are short, and the distance from their blind lower ends to the urogenital sinus is considerable. At parturition, an actual rent is made in the tissues intervening between the median vagina and the urogenital sinus, and the nascent

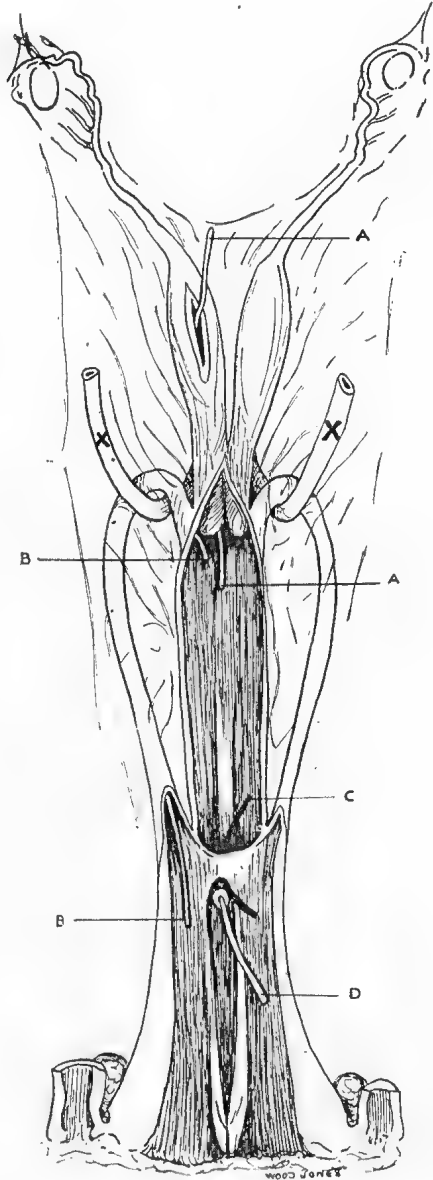


FIGURE 47.—The reproductive system of a female Nail-Tailed Wallaby. A. A. is a probe inserted through a hole made into the uterus and passed out through the orifice of the uterus into the median vagina. B. B. is a probe passed along the lateral vagina. C. is a bristle placed in the opening of the median vagina to the exterior. The probe D. is in the outlet of the urethra. In this animal the median vagina is an open canal. The ureters are indicated by X.

young pass through this newly formed channel. This channel once formed during parturition remains permanently open in some species (such as kangaroos), but in some (such as the bandicoots) it closes up again, only to be re-opened at the next act of parturition.

The condition of the reproductive system of practically all the marsupials is now well known, and a medium vaginal passage, formed in the first place during parturition, and in some types reformed at each subsequent act of parturition, constitutes the route of birth in all. Although the median vagina becomes a permanent structure in many forms, nevertheless, the lateral vaginae still serve as the channels of fertilisation. The lateral dilatations of the lateral vaginae, which serve as receptacula seminis, find their parallels in other animals, and their presence is probably responsible for the very strange irregularity which has frequently been noted in the period of gestation of such marsupials as kangaroos, which are commonly kept in captivity. The following records relate to the Red Kangaroo (*Macropus rufus*):—A female, which paired on a single occasion, May 22nd, 1921, died 28 days later, and in her pouch was an embryo 55mm. in length. In several cases pregnancy has been recorded as lasting from 30 to 40 days.

A female and a male were kept together; in February, 1922, the male died, and on July 4th, 1922, an embryo “not so large as the diameter of a shilling” was found in the female’s pouch. The interval in this case was some 130 days. A male and a female sent to the Zoological Gardens in Philadelphia lived together, the male dying on October 28th, 1908. An embryo was noticed in the pouch seven weeks after the male died. This young one suckled till November 7th, 1909; but on September 25th, 1909, another, apparently new born, embryo was noticed in the pouch. The interval in this case being eleven months all but three days. These curious cases are not without their parallels in the Monodelphia, and the European Badgers, certain Stags, and the Bats of cold countries might be instanced as examples of animals notorious for possessing very irregular and sometimes greatly prolonged periods of “gestation.”

Two other rather strange phenomena may be noticed in connection with marsupial reproduction. In many monodelphian Mammals there is an over-production of embryos; more eggs are fertilised, and more embryos start to develop than ever come to maturity. That is a well known state of affairs. But in certain Didelphia the over-production goes further than this, for, as Professor Thomson Flynn has noted, six embryos may be produced in the Tasmanian Ring-tailed Opossum which never rears more than two young. Some of these excess young probably do not reach the pouch; but some do, and then failing to find an unoccupied nipple, perish.

Again it may happen that the embryo in one uterus differs in size and age somewhat widely from that in the other uterus; or a very immature embryo may be present in the uterus while a new-born young animal occupies the pouch.

The young marsupial at the time of its birth is very small in proportion to the size of the parent animal, but small though it is it evinces a high degree of vitality and an astonishing power of movement. New born young will remain alive for a considerable time after the death of the mother, and if taken in the hand are capable of wriggling about with remarkable vigour.

As we have already noted, the newly born young of the pouchless marsupials has no greater task confronting it than has the young of the Monodelphia. It merely has to find a nipple and grasp it. We know quite well that the monodelphian mother assists the young to do this; and the didelphian mother probably does the same.

In the pouched forms, the young, in order to grasp the nipple, has to get into the pouch. In this further enterprise it is also most probably assisted by the mother; and in this connection it is to be noticed that the mouth of the marsupium is directed so that it is in the situation most easily reached by the mother. The position most easily reached depends upon the general build of the mother. Female marsupials frequently examine their pouches, and before parturition a female opossum is constantly looking into her pouch, holding its mouth open with her hands, and thrusting her nose within its cavity. In all probability the mother assists the young to effect its entry into the marsupium, and it is reasonable to suppose that she does it with her nose and tongue in the manner in which a monodelphian mammal guides the young towards the nipples.

When once the young has grasped the nipple, its mouth becomes adapted to its circular form, and instead of the gape between the lips being slit-like in shape it becomes rounded.

As John Hunter said, "the sides of the mouth are united something like the eyelids of a puppy just whelped." The nipple, which passes far into the mouth of the embryo, dilates at its tip and so cannot be pulled from the mouth without causing some injury to the sealed lips. As the young marsupial grows larger the fusion of its lips becomes undone—as the eyelids of a puppy part when the eyes open—and then the nipple may be freely withdrawn from the mouth. The number of nipples varies in the Australian marsupials from 2 in the Wombat

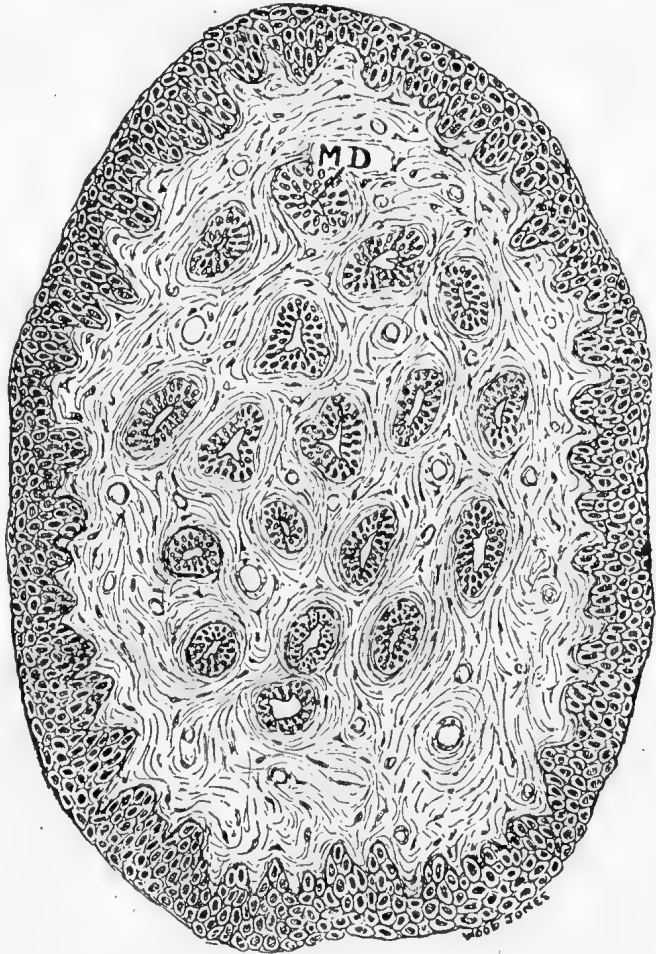


FIGURE 48.—Transverse section of the nipple of a wallaby. The young one had been recently born and was hanging to the nipple. The specimen was prepared by cutting thin slices through the head of the young animal, the nipple being sliced as it was held in place in the young animal's mouth. The slice is shown as seen under a microscope. Eighteen little ducts (M.D) convey the milk along the nipple to the offspring.

and the Koala and some of the Opossums to 10 in certain Pouched Mice. The nipples are inconspicuous and inverted until they begin to develop for their adult function and are pulled out by the suckling offspring. The section across the nipple of a wallaby is shown in Figure 48, and it will be noticed that it is traversed by no canal save the minute ducts along which the milk passes from the mammary glands.

THE DISTRIBUTION, AND PAST HISTORY OF THE DIDELPHIA.

The Didelphia at present inhabit Australasia (exclusive of New Zealand) and certain parts of America. The American marsupials, although an extremely interesting group, constitute a struggling minority, and Australasia to-day can claim to be the stronghold of the most specialised, and the most perfected, examples of marsupial development.

In Australasia there are about four times as many species living as are comprised in the whole of the existing marsupial fauna of America. In the New World, the vast bulk of the species is confined to South America; but certain forms range through Central America, and some few extend northwards to the southern United States. In Australasia, their distribution extends through the Malayan Islands from Celebes, Gillolo, Ceram, Amboyna, Waigou, Aru, Key, Salayer, Buru, and Timor to New Guinea, and as far to the east as the Louisiade Archipelago. They range through the whole of the continent of Australia, and into the small islands of the continental shelf, and so to the extreme south of Tasmania.

In Australasia the marsupials have become established, and the probable route of their invasion has already been discussed (pp. 20-23). In that discussion we noted that very different views are entertained by zoologists upon the question of the road by which the marsupials arrived in Australia.

When we turn to the other question—"When did the marsupials arrive?" we meet with a still greater diversity of opinion. But though there are very different ideas as to the duration of their tenancy of Australia, there is a very definite tendency for each fresh addition to our knowledge to force us to the belief that this tenancy has, geologically speaking, not been a very long one.

Sir Richard Owen assumed that the Marsupials had been in Australia from Mesozoic times, and many authorities have placed the period of their advent in the Jurassic. Some have, however, shortened their tenure to the Cretaceous period, and some even have limited it to the Eocene epoch of Tertiary times. Zoologists, for the most part, have been impressed with the evidence of the comparatively recent stamp of the marsupial radiation in Australia. There is one thing that is very certain, namely, that during the period which corresponds to the Pleistocene of Europe the Didelphia were well established all over the continent of Australia; and that during this period they ran riot in the production of peculiar and outstanding forms, which have since become extinct. During this period, the relatively gigantic Diprotodons lumbered about the now arid regions of the Centre, the very formidable flesh-eating *Thylacoleo* flourished, and the huge extinct kangaroos ranged over practically the whole of the continent. Since that time the Australian Marsupials have passed their hey-day, and we are witnessing the all too rapid extinction of the stock. In Europe, the Marsupials had all died out at the beginning of the Miocene period, and from North America they had already passed as early as

the Oligocene. Their future tenure of Australia depends upon the realisation by the people of Australia of the scientific value of their heritage of Marsupials—a heritage for which they are responsible to the whole world. In studying the living Marsupials of Australia, we are at first struck by the remarkable fact that, in a general way, they have become modified along just the same lines as have been followed by the monodelphian mammals of the rest of the world. This phenomenon of Convergence we have already discussed. But, when the modifications of the whole of the didelphian series are passed in review, it at once becomes apparent that, though there is a considerable degree of diversity of marsupial forms, this diversity is not nearly so great as that which exists among the Monodelphia. We may say that a greater likeness exists between all marsupials than exists between the very diverse types of higher mammals. There is a striking underlying similarity between all Didelphians. They have radiated and become modified; but their modifications have not proceeded so far as have the modifications of the Monodelphians. There is more underlying likeness, for instance, between a kangaroo and a native cat than there is between a bat and an elephant. We may say that, whereas, in the Monodelphia, modification of the stock has proceeded so far that several separate Orders have to be created in the classification to accommodate the very diverse forms, the whole of the Australian Didelphia may be placed within the limits of a single Order.

Now, this state of affairs is probably brought about by two factors. In the first place, the Didelphia, as a group, have largely lost their plasticity. They are not able to react quickly to their environmental demands, or to adapt themselves by structural modification to all sorts and conditions of new circumstances. In the life of an individual—even a human individual—there is a time during which change, in response to new demands of the environment, can be readily and rapidly effected. So, too, in the life of a stock or *phylum*, there is a period of youthful plasticity, and a time when this plasticity becomes less and less; and in the end a stock becomes phylogenetically senile in the same way that an individual becomes aged. Regarded in this way, it may be said that the Didelphia have become phylogenetically senile; they have outlived their time of greatest plasticity, and now cannot adapt themselves so readily to new conditions. It was apparently in Pleistocene times that the Australian Didelphians ran their riot of phylogenetic plasticity, and since then they have sunk into phylogenetic decrepitude.

This lack of plasticity, no doubt, accounts in part for the comparative lack of diversity displayed by the existing forms of the Australian marsupials. But in part this sameness is probably also due to the relatively recent nature of the radiation of the marsupials into Australia. If we take such a feature as the pattern displayed by the coats of the Marsupials, we are at once struck by the wide prevalence of the loin banding. This type of pattern is seen in such diverse Marsupials as the Tasmanian Tiger (*Thylacinus*); in the Banded Ant-eater (*Myrmecobius*); in certain of the Bandicoots; and in some of the Wallabies. The prevalence of so variable a feature as a particular type of coat pattern throughout the whole of the most widely separated members of the Australian Marsupials appears to indicate that their diversity is comparatively recent. They are diversified as the result of their original radiation into Australia, but it would seem that their radiation had not started very long ago, when time is reckoned by geological epochs.

THE PLACE OF THE DIDELPHIA IN THE MAMMALIAN PHYLUM.

Some years ago there would have been but little difficulty involved in the discussion of the question as to the relationship of the Didelphia to the Monodelphia on the one hand, and to the Ornithodelphia on the other. When once evolutionary principles, even of the crudest kind, had been grasped, it was easy to assign an intermediate position to the Didelphia; to regard them as representing half-way houses in development between the primitive Ornithodelphian and the more elaborated Monodelphian. Haeckel, for instance, was quite dogmatic in his teaching; and he says "Metatheria or Marsupialia are direct descendants of Prototheria: but they show higher development by the reduction of the coracoid bones," etc. Of the Monodelphia, he says that they are "a further development of the Metatheria by the development of a placenta, loss of the marsupium and the marsupial bones," etc. In 1898, when Ernst Haeckel wrote his essay* the whole sequence seemed easy, and the line of thought he followed was a very simple one. To picture the stage intermediate between a mammal which lays an egg, and a mammal which produces a well matured offspring, as being a creature which produces a very immature embryo—such as that typical of the marsupials—is perfectly natural. The reproductive story of the Didelphia seemed to be an ideal stepping stone between the egg-laying habits of the ornithodelphian Platypus, and the begetting of a remarkably mature offspring of, say, the monodelphian mare.

Again, we have seen that the Platypus lays eggs, but has no pouch; whereas *Echidna* lays eggs, and develops at the breeding season a pouch in which the egg is placed, retained, and hatched; and within which the young is nourished by a nutrient fluid or "milk."

It appears a very simple step to the Didelphian, where an immature young animal—a stage only very little advanced from the egg—is placed in a pouch when it is born. It also seems a simple step from the milk glands without nipples, seen in the Ornithodelphia, to milk glands with nipples, typical of the Didelphia. It would appear natural, also, that, as the offspring was born more and more mature with the progress of evolution, the pouch should ultimately be dispensed with, and the monodelphian condition attained.

Unfortunately, a series of well ascertained facts upsets our belief in this very simple evolutionary story, and it is quite impossible to accept Haeckel's easy assertions as to the intermediate position of the Didelphia.

In the first place, although it might seem obvious that the didelphian "pouch" was the direct descendent of the ornithodelphian "pouch," we are faced with the disconcerting fact that the most generalised, and most primitive Didelphians have no "pouch" of any kind.

Contrary to what is the general notion concerning the marsupials, it is, nevertheless, certain that the pouch was no birthright of the didelphian stock; the "marsupium" is a marsupial acquirement, and a marsupial specialisation; it is by no means a didelphian birthright.

So much a mere study of the animals tells us, for when we examine a marsupial such as *Myrmecobius*, which shows a maximum of archaic, primitive, or generalised characters, we find no trace of a pouch at any period of the animal's life cycle.

*The Last Link, London, 1898, pp. 66—67.

From such an entirely pouchless condition we may pass, by easy gradations, to partially and temporarily pouched forms, and finally to permanently and perfectly pouched forms; this last group being the most completely specialised marsupials, but the least primitive Didelphians.

No amount of ingenuity can make it a credible thesis that the most completely pouched Didelphians are the most primitive, since in every other feature of their bodily anatomy they are obviously the most specialised away from a primitive condition. It therefore seems hopeless, on mere commonsense grounds, to attempt to explain the marsupial pouch as an inheritance of the ornithodelphian pouch of *Echidna*; and this commonsense view is backed by every finding of science, and science should be merely a synonym for applied commonsense.

The *Incubatorium*, or brooding pouch, of *Echidna* is in its inception, its structural basis, and in its developmental history a thing altogether different from the *Marsupium*, or mammary pouch, of the more highly specialised marsupials.

We have spoken previously of the importance of the phenomenon of Convergence, by which not only individual bodily structures, and organic systems, but the whole summation of structures expressed in the form of an adult animal, may come to be moulded in a similar fashion in response to similar environmental needs. By convergence, in distinct opposition to inheritance, or kinship, the marsupial Mole comes to resemble the monodelphian Mole. By convergence, in distinct opposition to inheritance, certain members of the Ornithodelphia and the Didelphia independently acquired a depressed area of the ventral abdominal surface, which, though known in both cases as the "pouch," is fundamentally a different structure in the two Sub-orders.

Although the Marsupium is no descendent of the Incubatorium, nevertheless, there are many structural points in which the Didelphia show their affinity with the Ornithodelphia. The epipubic bones, and the brain lacking a true corpus callosum, may be mentioned as structural affinities of Marsupials and Monotremes. The didelphian stock is obviously allied to the ornithodelphian, even if its relationship to that stock is not of so simply derivative a kind as was at one time supposed. But if the relationship of the Didelphia to the Ornithodelphia cannot be regarded as one of perfectly simple descent, the relationship of the Didelphia to the Monodelphia is, still more obviously, not one of simple ancestry.

If the didelphian series be arranged in a sequence, from those forms which show a maximum of primitive characters to those which evince the greatest degree of specialisation, it is at once apparent that it is the most primitive, and not the most specialised Didelphians which most resemble the Monodelphians. It is not that a didelphian stock underwent progressive evolution, and culminated in the production of a monodelphian type; for the lowest, and not the highest, Didelphians are most like the Monodelphians. The two great stocks meet at their bases—the base of the higher does not start from the apex of the lower. The meeting of the didelphian and monodelphian stocks at their bases is well shown in the reproductive story of the two groups. The most primitive Didelphians possess no pouch, and in all the more primitive forms the pouch is of only moderate development. The young animal, before its birth, establishes connection with the maternal uterus by means of a placenta, which, though comparatively short-lived as a functioning

organ, is nevertheless fashioned definitely in a manner familiar in the Monodelphia, or so-called "placental." Mammals. The young animal is born immature, and hangs on to the maternal nipple; but, in the primitive Didelphians, the nipple, and the young, are not protected within a marsupium.

All this is very like the state of affairs present in the lowest Monodelphians, for, in many placental Mammals, the placenta functions for a comparatively short time, and the young is born singularly immature; moreover it is the custom in many Monodelphians for the young to hang extremely tightly to the nipples, and to be thus dragged about by the mother in all her activities.

It may be said that the reproductive history of the most primitive marsupials, and the most primitive placentals is, on general lines, not very dissimilar. It might also be added that the Didelphians seem to have specialised in the development and protection of immature young; whilst the Monodelphians have advanced in the direction of begetting a more advanced offspring.

But though, in structure and function, we find a very striking similarity between primitive Didelphians and primitive Monodelphians, it is a very great mistake to suppose that the two groups actually lose their distinctive characters when traced back to their bases. In speaking of the Didelphia (Metatheria) the authors of one of the most recent publications* on the Australian fauna say, "There is not a hard and fast definition by which they may be separated from the Eutheria" (Monodelphia). There is, however, one hard and fast definition which will suffice, and this one is of the utmost importance. In the Didelphia the ducts of the kidneys (ureters) pass between the oviducts; in the Monodelphia the oviducts pass between the ureters. This difference is one which is established very early in embryonic life, at the time when the kidneys are developing; and it is the essential factor which determines the reproductive peculiarities of the two great subdivisions of the Mammalia. Since the ureters pass between, and separate, the oviducts of the Didelphia, these ducts cannot meet in the mid line, and fuse to form a large single median uterus with a wide bored median orifice opening to the exterior. The offspring of the Didelphia must therefore always be born prematurely, or, at any rate remarkably small, when compared with the size of the parent.

From the condition of the oviducts and ureters present in the Ornithodelphians, it is easy to derive either the condition typical of the Didelphia, or that typical of the Monodelphia; just as the derivation of either didelphian or monodelphian type is simple from the condition present in the early embryo of either.

We may, therefore, picture the Didelphia and the Monodelphia as arising from a common, and more primitive stock, which, in many of its characters, resembled the Ornithodelphia.

From this common stock the Didelphia developed along a line expressed by, among other things, the degeneration of the allantoic placenta, the curtailment of intra-uterine life, the begetting of immature offspring, and the development of a marsupium or pouch in which to shelter them. Whereas, the Monodelphia diverged by, among other things, the elaboration of the allantoic placenta, a prolongation of intra-uterine life, and the begetting of a somewhat more mature offspring.

* Animals of Australia. Lucas and Le Souef, p. 3.

THE CLASSIFICATION OF THE DIDELPHIA.

To arrive at a thoroughly satisfactory classification of the Didelphia is by no means an easy matter; and the difficulties that are encountered will depend, to some extent, upon the motive that underlies the attempt to arrange the Marsupials in an orderly series.

Classification may be undertaken merely with the idea of arranging specimens in a collection, or agreeing upon the order in which the animals should be placed in a catalogue, or a book. Or the arrangement may be planned in order to make some attempt to express actual lines of descent, and degree of relationship. It seems obvious that a scheme of classification that tells us something of the real affinities of the animals is to be preferred to one that only attains a certain degree of systematic orderliness.

The whole assemblage of the Australian Marsupials is readily divided into two main groups by reference to the structure of the pes. It is also divided into two different groups by reference to the characters of the dentition. We may say, in brief, that, if our aim in classification is to make an ordered arrangement of a collection of specimens, the dentition constitutes the best criterion; whereas, if our aim in classification is to show true genetic affinities, the structure of the pes is probably the safest guide.

There are among the Marsupials, as among the Monodelphia, certain forms which are carnivorous, and others that are herbivorous. No classification by dietary can ever be a very precise one, for some animals will certainly be met with which are neither wholly flesh eaters, nor wholly vegetarian. Nevertheless, the dentition of an animal shows, as a rule, into which class the creature should be placed; for the teeth usually betoken the habit, and the heritage of an animal's dietary in an unmistakable manner. Arranged by the dental characters, the Marsupials, therefore, fall into two groups; the one group having, on the whole, a carnivorous type of dentition, and the other an herbivorous type. In the flesh eaters, there is usually a full set of anterior teeth; but in the vegetarians, the front teeth tend to be few in number, though large in size as individual teeth. The flesh-eating Marsupials were, therefore, isolated into a group having as a well-marked characteristic the possession of numerous front teeth; and this group was, accordingly, named *Polyprotodontia*. The vegetarian group was distinguished as the *Diprotodontia* in consequence of the reduction in the number of front teeth. The division of the Didelphia into two groups, Polyprotodontia and Diprotodontia, is the standard classification adopted in most text books of zoology. Within the last twenty years, however, there has been a tendency, on the part of many workers, to attach greater importance to the structure of the pes as a guide to classification; and Bensley, among others, has emphasised the value of the study of the condition of the pedal digits. Judged by the characters of the foot, the Australian Marsupials may be arranged in two groups, named *Didactyla* and *Syndactyla*. In the *Didactyla* the foot is characterised by the possession of the primitive arrangement in which all the digits remain separate and independent of each other. In the *Syndactyla*, the 2nd and 3rd pedal digits are bound together, over the greater part of their length, so that they appear as a single toe possessing two toe nails.

For the most part, the Polyprotodontia are also Didactyla ; and the Diprotodontia are Syndactyla. That is to say, most of the carnivorous Marsupials, with many front teeth have their toes separate ; whereas the vegetarian Marsupials, with few front teeth, have the 2nd and 3rd toes united.

Unfortunately, the Bandicoots (*Peramelidae*) spoil the agreement of these two schemes of classification, for these interesting animals, which are mixed feeders, are Polyprotodont, and yet they have typical syndactylous 2nd and 3rd toes.

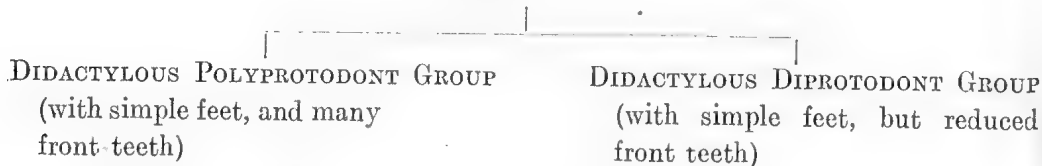
If the characters of the dentition be relied on, one Sub-order (DIPROTODONTIA) is created, in which all the animals have a reduced set of front teeth, and all possess syndactylous digits. The other Sub-order (POLYPROTODONTIA), however, contains an assemblage of animals, all of which have a full set of front teeth, but some have simple feet, and some (the Bandicoots), have feet like those of the animals contained within the other Sub-order.

If, on the other hand, the feet be used as the criterion, we have a Sub-order of simple-footed animals (DIDACTYLA), all of which have a full set of front teeth ; and a Sub-order of syndactylous animals (SYNDACTYLA), all of which have reduced front teeth, except the Bandicoots.

In such a case as this, it is necessary to make some attempt to determine the relative values of the characters used as criteria for classification. There is no doubt that didactylism is the simple and primitive condition ; and that syndactylism is a specialised, or derived character. There is equally no doubt that the diprotodont condition is the specialised form which has been derived from the more primitive polyprotodont condition. We may, therefore, feel fairly certain that the most primitive didelphians were polyprotodont and didactylous ; and that the diprotodont and syndactylous forms are the most highly specialised expression of Marsupial development.

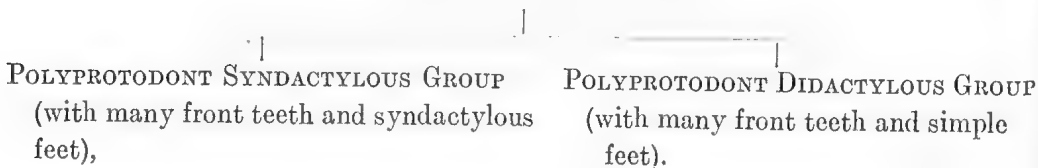
Has a primitive didactylous stock split up into polyprotodont and diprotodont forms ? or has a primitive polyprotodont stock split up into didactylous and syndactylous forms ? If the first supposition were true, we should expect to find, either as living or fossil forms, marsupials having reduced front teeth, but with simple feet, thus :—

DIDACTYLOUS STOCK.

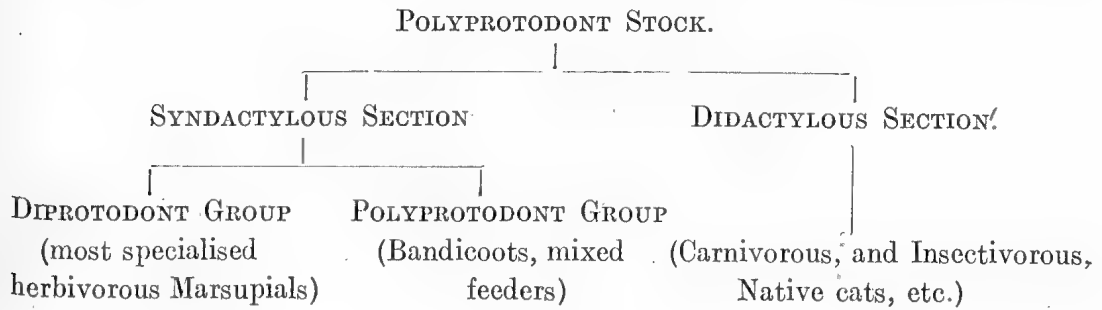


No didactylous diprotodont marsupial is known. On the other hand, if the second supposition is true, we shall have the following groups :—

POLYPROTODONT STOCK.



Both these divisions are represented in the living Marsupial fauna of Australia. We have further to picture, as a subsequent development of this, the specialisation of a dentition with reduced front teeth among the vegetarian syndactylous division, as follows :—



From the genetic point of view, it, therefore, seems obvious that the two main divisions of the Didelphia are the *Didactyla* and *Syndactyla*, and not the more usually employed *Polyprotodontia* and *Diprotodontia*.

Despite the fact that all current works on systematic zoology still adopt the classification by teeth introduced by Sir Richard Owen, the more recent suggestions of Bensley and others will be used as a basis here, and the major classification will be by foot structure. The following probably represents as true a picture of the relationships of the various groups as can be constructed in the present state of knowledge.

Didactylous Group.

Most primitive members of the Didelphia, in many ways most resembling the more primitive members of the Monodelphia. The pouch is commonly either altogether absent, or is rudimentary ; but in some forms it is well developed ; its opening is directed ventrally, or caudally. The teeth are adapted to an insectivorous, or carnivorous diet. The bulk of the didactyla are exceedingly lithe, active creatures ; possessing that general ability for climbing, which enables them to ascend trees without their being strictly arboreal animals. Some are bush haunting animals, some are terrestrial, and one is fossorial. They are, as a rule, alert, intelligent creatures, preying upon almost any living thing that they can overpower and kill. As is common with carnivorous creatures, a species is not represented by a great number of individuals ; and many are excessively rare.

The group embraces the Native Cats and Tiger Cats ; the insectivorous Pouched Mice ; the Tasmanian Devil, and the Tasmanian Tiger ; the Banded-Ant-eater, and several small weasel-like forms. The most primitive members of the group are probably to be seen among the *Phascogalinae*, while the most specialised are the large existing carnivorous Marsupials of Tasmania, and the jumping *Antechinomys*, and the burrowing *Notoryctes* of the Centre.

Syndactylous Group.

Most specialised representatives of the Didelphia. The most primitive members of the group are the mixed-feeding, but largely carnivorous, Bandicoots. The

Bandicoots possess the full series of front teeth typical of the Didactylous group, and they are an active, predatory, and relatively intelligent family of generalised Marsupials. The most specialised of the Bandicoots are the Rabbit Bandicoots (*Thalacomys*), and the Pig-footed Bandicoots (*Choeropus*). The pouch is shallow in all, and the opening is ventral.

The remainder of the Syndactyla are vegetarians, and show a reduction in the number of the front teeth. This section includes the various Opossums, the Kangaroo Rats, the Wallabies, and Kangaroos, and the Wombat and Koala. All these animals are highly specialised; but the least modified of them all are the Opossums.

In all of them the pouch is well developed, and its opening is directed forwards. They are arboreal; saltatory, terrestrial; or fossorial. They are, for the most part, rather markedly unintelligent, and many are distinctly phylogenetically senile. They are the end products of Didelphian development, the most advanced phase of specialisation of the Marsupial stock.

SUB-CLASS II.—DIDELPHIA.

ORDER, MARSUPIALIA.

SUB-ORDER I.—DIDACTYLA.

KEY TO THE SUB-ORDER.

(A) With well developed eyes, and external ears. Cervical vertebrae not fused together. In the general appearance there is nothing mole-like.

(B) With well developed molars— $\frac{4-4}{4-4}$

(C) Hallux well developed. Tail wholly, or in part, naked; prehensile. Family 1. *Didelphidae*.

(C¹) Hallux not well developed; often absent. Tail more or less hairy; not prehensile.

(D) With molars having many secondary cusps.

Family 2. *Dasyuridae*.

(D¹) With molars having few secondary cusps.

Family 3. *Thylacinidae*.

(B¹) With degenerate molars exceeding $\frac{4-4}{4-4}$

Family 4. *Myrmecobiidae*.

(A¹) With eyes atrophied, and external ears absent. Cervical vertebrae fused together. General appearance mole-like. Family 5. *Notoryctidae*.

FAMILY I.—DIDELPHIDAE.

The members of this Family are carnivorous Marsupials, and are the animals to which the name of "Opossum" rightly belongs. They are all confined to America.

FAMILY II.—**DASYURIDAE.**

This Family is most conveniently divided into two Sub-Families.

- (A) Medium sized animals ; in general form like the Martens or smaller Felidae among the Monodelphia. Carnivorous. Upper premolars 2-2.

Sub-family 1. *Dasyurinae*.

- (A¹) Small animals ; in general form like the Shrews and Tree Shrews among the Monodelphia. Insectivorous. Upper premolars 3-3.

Sub-family II *Phascogalinae*.

SUB-FAMILY I.—**DASYURINAE.**

Division of the Sub-Family into Genera.

- (A) Fur not spotted. Skull with the brain case small and muzzle broadened.

Genus 1. *Sarcophilus*.

- (A¹) Fur spotted. Skull with the brain case relatively large and the muzzle elongated.

Genus. 2. *Dasyurus*.

GENUS 1. **SARCOPHILUS** (F. Cuvier, 1837).

This Genus contains only a single living species—the so-called Tasmanian Devil. The animal formerly ranged over continental Australia, but is now confined to Tasmania, where it maintains a rather precarious foothold in the wilder parts of the country.

In 1912 a Tasmanian Devil was captured in Victoria, and another was reported as having been seen (*see* Kershaw, Vict., Nat. xxxix., 1912, p. 76). In the absence of any additional evidence it is perhaps prudent to regard these animals as being specimens escaped from captivity, rather than as survivors of the ancient race which inhabited continental Australia ; nevertheless, this possibility must not be overlooked.

GENUS 2. **DASYURUS** (Geoffroy, 1796.)

The animals embraced within this Genus roughly resemble small Cats, and they are known as Tiger Cats or Native Cats. The rhinarium is naked and grooved. The ears are long and somewhat pointed. The body fur marked with white spots. Tail long and uniformly hairy. The soles and palms naked, or nearly so ; granular in texture. Hallux reduced or absent. Digits armed with strong claws. Pouch present, opening downwards. Nipples 6-8 ; arranged in two curved rows. Active animals, capable of climbing ; but most species not truly arboreal. Often living in rocky and treeless areas. Carnivorous and insectivorous. Dentition—I. $\frac{4-4}{3-3}$
C. $\frac{1-1}{1-1}$ PM. $\frac{2-2}{2-2}$ M. $\frac{4-4}{4-4}$.

Three species are recorded from South Australia.

KEY TO THE SOUTH AUSTRALIAN SPECIES.

I. External characters—

(A) Size large. Tail spotted. Pads of feet striated. Hallux present. *D. maculatus.*

(A¹) Size medium. Tail not spotted. Pads of feet tuberculated.

(B). Hallux absent. Tail (in typical colour form) becoming paler at tip. *D. viverrinus.*

(B¹) Hallux present. Tail becoming darker at tip. *D. geoffroyi.*

II. Cranial characters—

(A) Bullae obliquely oval. Molars 1-3 18mm. or more. *D. maculatus.*

(A¹) Bullae spherical. Molars 1-3 less than 18mm.

(B) Posterior part of palate comparatively perfect. *D. viverrinus.*

(B¹) Posterior part of palate with large vacuities. *D. geoffroyi.*

(1) Tiger cat. Spotted-tailed native cat.

DASYURUS MACULATUS (Kerr, 1792).

The name Tiger cat which is usually bestowed upon this animal is a somewhat flattering one; for, although a particularly well equipped carnivore, its comparatively small size hardly justifies its comparison with the true Tiger Cats of the genus *Felis*.

Specimens are said to have been seen as large as a common fox; but a head-and-body length of about two feet may be regarded as a fair average size.

In general build it is like the Martens of the northern hemisphere, and Captain Phillip, who saw the animal in Tasmania, and was the first to record its existence, named it the "spotted marten."

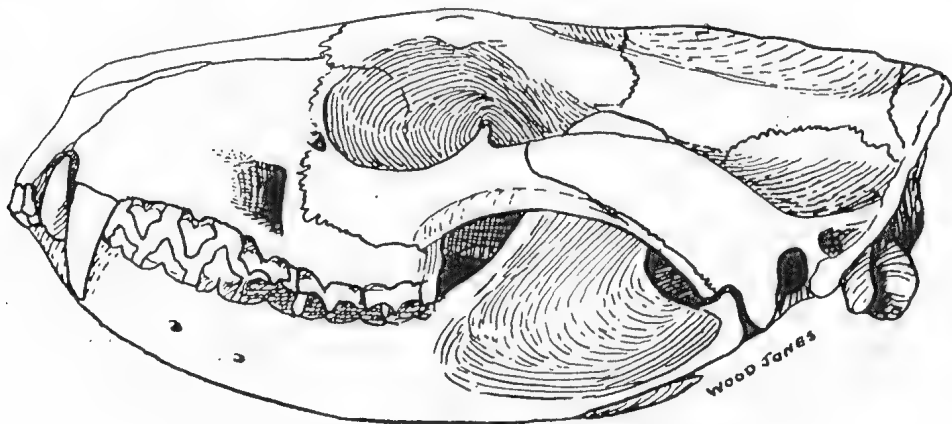


FIGURE 49.—Skull of *Dasyurus maculatus*. Natural size.

The fur is thick, harsh, and rather short. Beneath the stiffer surface hairs of the coat is an abundant soft brown under fur. The general colour of the dorsal surface of the body varies from a rich rufous brown to dark brown. The inner side

of the limbs, and the ventral surface of the body, are paler, and vary from pale yellow to sandy. The face is paler than the general colour of the dorsal surface of the body, and the short hairs which clothe the face and head are somewhat grizzled.

The manus and pes, like the inner surface of the limbs, are pale in colour. The tail is clothed with rufous brown hair which is of the same colour as that of the general dorsal body surface. The body and tail are spotted with white patches; but the spotting varies considerably in different specimens. For the most part the spots are confined to the sides of the body, the outer sides of the limbs, and the tail. Upon the face the spots are either small and inconspicuous, or else are entirely absent. Upon the body the spots are irregular in size and shape, and they vary from a mere dot to patches as large as a shilling. The presence of spots upon the tail distinguishes it at once from the smaller *D. viverrinus*. The tail is long, in most examples being about one sixth shorter than the total length of head and body. It is uniformly clothed with rather long harsh hairs. The ears are short, the inner surfaces are pubescent with short yellow hairs, and a tuft of pale hair covers the basal portion of the inner surface. The outer surface is clothed with hair of the general body colour. The rhinarium is dark flesh-coloured, granulated and cleft in the mid line. The eye is brown. The vibrissae are well developed, the mystacial set reaching upwards of 90mm. in length. All facial bristles present. Ulnar carpal and medial antibrachial sets well developed. The manus with naked palm and five well developed pads with small striated areas. Digital formula $3 > 4 > 2 > 5 > 1$. Claws strong and curved. The pes with naked sole, save posteriorly, where hair from the margins clothes the immediate neighbourhood of the heel. Hallux very small and clawless. Five prominent striated pads. Digital formula $3 > 4 > 2 > 5 > 1$. The pouch is shallow. The nipples are 6 in number, and are arranged in two crescentic lines.

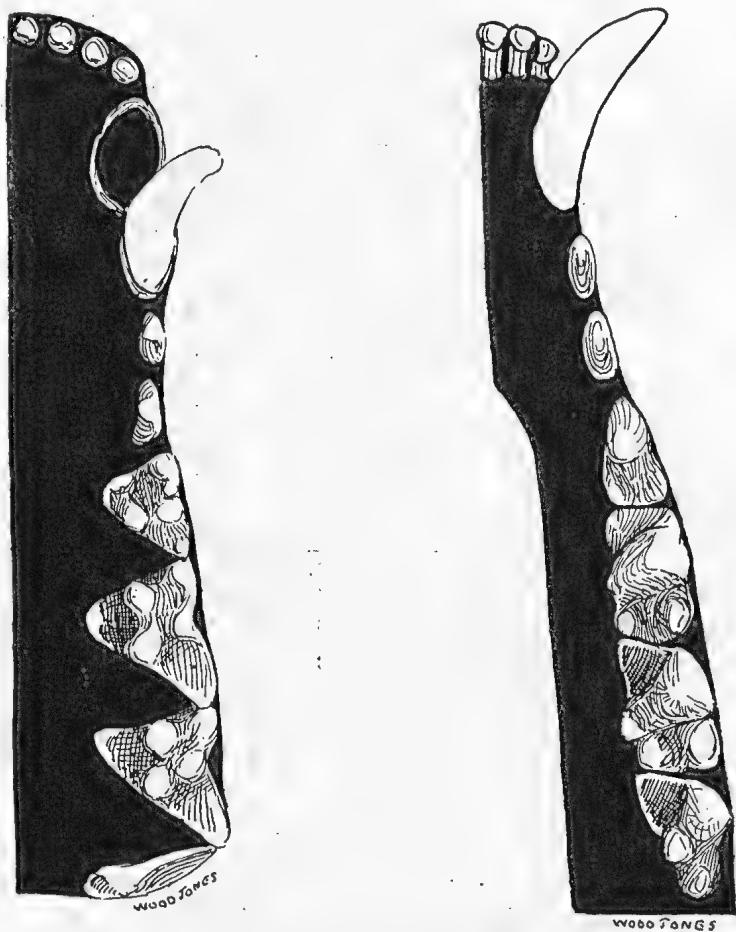


FIGURE 50.—Left upper and right lower teeth of *Dasyurus maculatus*. Twice natural size.

The skull is powerfully built, and all the muscular ridges are highly developed (see Figure 49). In proportion to the general size of the skull, the brain case, as was pointed out in Figure 35, is remarkably small, though not so dispro-

portionately so as in the Tasmanian Devil. The teeth are large and powerful (see Figure 50), and the distance from the front of the first molar to the back of the third molar measures 18mm. or more. The *bullae*, or swellings of the base of the skull beneath the bony cavity for the ear, are elongated, and they are about twice as long as they are broad; their characteristic features are shown in Figure 51. They differ markedly from the bullae of other members of the Genus.

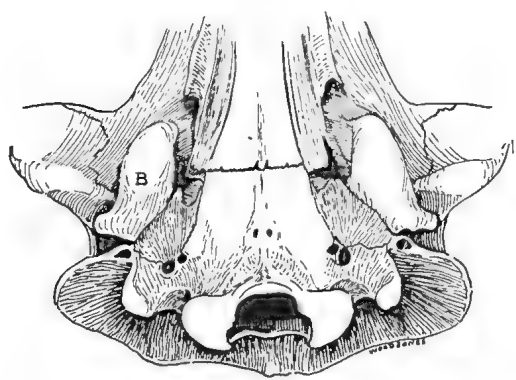


FIGURE 51.—Underside of the posterior end of the skull of *Dasyurus maculatus*. The Bulla on the left side of the figure is marked B. Natural size. Compare with Fig. 55.

DIMENSIONS.

	Ogilby's Catalogue. Skin.	Queensland Mus. Skin. ♂	Brit. Mus. Cat. Skin. ♂	Waterhouse. Skin. ♂	Queensland Mus. Skin. ♂	Waterhouse. Skin. —
Head and body ...	635	620	620	610	590	432
Tail	480	500	470	507	480	381
Hind foot	—	80	76	With claw, 89	80	With claw, 50
Ear	—	—	C. 24	28	—	25

DIMENSIONS OF SKULL.

	Australian Mus. — Krefft.	Tasmanian Specimen.	Queensland Mus. ♂	Queensland Mus. —	Queensland Mus. —	Tasmanian Specimen. Brit. Mus. ♂	Queensland Mus. —	South Australian Specimen.	Queensland Mus. ♂	Queensland Mus. ♂	Waterhouse.	Queensland Mus. ♂	Queensland Specimen. Brit. Mus. ♂	Waterhouse.	Queensland Mus. ♂
Basal length ..	115	109	108	107	105	104	101	98	94	93	88	86	84	—	79
Breadth	—	70	70	70	66	67	—	64	57	57	53	—	58	—	47
Nasals, length ..	—	41	—	—	—	37	—	35	—	57	53	—	35	—	—
Palate, length ..	—	—	59	58	58	54.5	57	—	52	55	—	51	51	—	—
Length of molar series	—	—	24	23	23	—	22	—	23	23	—	23	—	—	22

By Krefft the animal is described as being “not only very ferocious, but also exceedingly stubborn,” and many accounts of its carnivorous habits, and its pluck as a fighter, are to be met with in works dealing with the earlier days of Australian colonisation. As would be imagined from its striated foot pads, and from the presence of the hallux, it is a tree-haunting species, and seems always to have been most numerous in the more wooded districts of the coast. Probably never abundant in South Australia, the stronghold of the species was in the south-eastern portion of the State. It is possible that some few still exist in the less closely settled areas of the South-East.

(2) **Native cat. Common native cat.***DASYURUS VIVERRINUS* (Shaw, 1800).

In form the animal is lithe and graceful ; it is lightly built, and its whole appearance is that of an agile, active, predatory carnivore.

The fur is thick and soft. The under fur is dense and fine, and except where the coat is spotted with white it is dark slate coloured. The colour of the general body fur is olive grey, warming slightly towards the sides, and markedly towards the tail, to a yellowish or rufous grey. The dorsal surface has often a distinctly greenish tinge which becomes yellowish or ruddy towards the basal portion of the tail. The ventral surface of the body, and the inner sides of the limbs, are pale grey, yellowish, or white. The fur of the general body surface is irregularly spotted with white. Some 50 to 60 spots, ranging in size from mere specks of a few white hairs to irregular blotches about the size of a sixpence, are present on most specimens. The spotting is inconspicuous on the face and head ; it is absent also from the free portions of the limbs, and the tail is invariably spotless.

The head and face are paler than the body, and are distinctly grizzled. The tail is markedly more rufous than the rest of the body, and the terminal tuft of hair is pale yellow or white. The manus and pes are white or pale yellowish grey.

The tail is considerably shorter than the head and body ; it is cylindrical and somewhat bushy in its basal portion, but towards the extremity the hair shows a very distinct tendency to form a dorsal crest. The ears are large, somewhat rounded in outline, and in the living animal they are carried folded. Fine white or pale yellow hairs clothe the backs of the ears and form a slight fringe on their margins. Within, the ears show a rim of fine hair round the edges, and a fine linear tract of hair along the line of folding. The processus antihelicis is large and broad, and presents a thick rounded margin. (See Figure 52.)

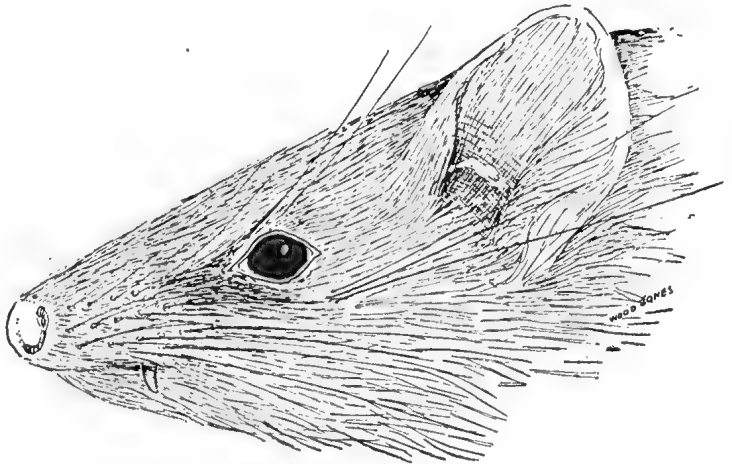


FIGURE 52.—Head of *Dasyurus viverrinus* from a male specimen. Natural size.

The rhinarium is naked, granular, and pink in colour in the living animal. It is cleft in its lower portion where it joins the upper lip. The eyes are fairly large. The iris is brown, the pupil circular. Eyelashes are well developed. The mystacial vibrissae are mostly dark in colour ; they measure 60mm. as a maximum, and they are arranged in 6 rows. There are 2 or 3 strong dark supraorbital vibrissae, a tuft of about half a dozen long dark hairs in the genal set, a few pale submentals,



FIGURE 53.—Left manus and pes of *Dasyurus viverrinus*.
Twice natural size.

ated granulations. A small pad marks the site of the absent 1st digit. The digital formula is $3 > 4 > 2 > 5$. (See Figure 53).

The pouch is somewhat shallow. The nipples are 6 in number, and are arranged in two crescentic rows.

The olive grey type, which is described above, is not the only colour variety of the species; for a melanistic form, in which the coat is black spotted with white; and a dark form, in which the body colour is brown spotted with white, occur in company with, and according to Gould, in the litters of the more ordinary type.

The skull is rather lightly built. (See Figure 54). The brain case is considerably larger in proportion to the size of the skull than in *D. maculatus*. The distance from the front of the first molar to the back of the third molar is about 14mm. The bullae are spherical and not elongated as they are in *D. maculatus*. (See Figure 55).

and a cluster of 4 or 5 white interramals. The ulnar carpal vibrissae, 3 or 4 in number, are well developed, and are white or pale yellow in colour. A single medial antebrachial bristle is well marked in most specimens.

The palmar surface of the manus is naked, granular, and flesh-coloured. There are 5 well developed pads. The thenar pad is merged with the first interdigital; the 2nd, 3rd, and 4th interdigital, and the hypothenar pads complete the series. In the centre of each pad is a large smooth granulation; this central granulation shows no trace of striations. The claws are strong and sharp. The digital formula is $3 > 4 > 2 > 5 > 1$. (See Figure 53).

The sole of the pes is naked, granular, and flesh-coloured like the palm. There are 3 well developed pads with central unstri-

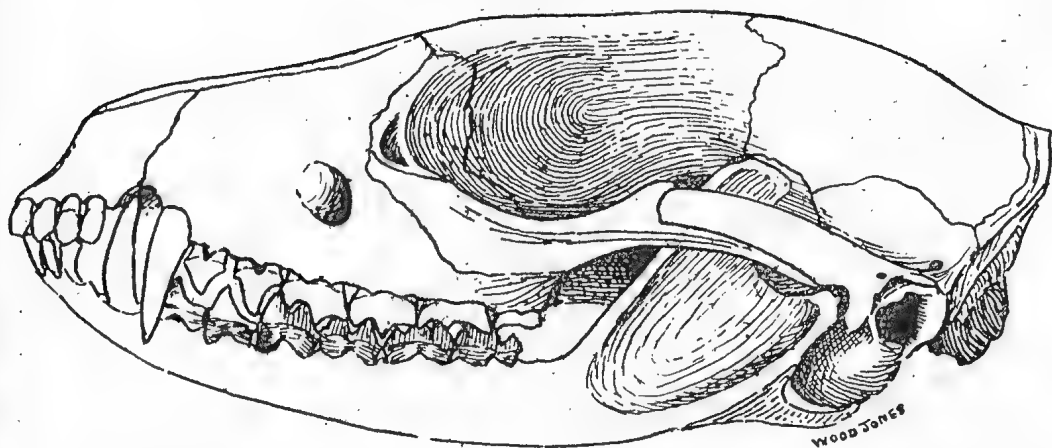


FIGURE 54.—Skull of *Dasyurus viverrinus*. Twice natural size. From a South Australian specimen.

DIMENSIONS.

	1. Ogibly.	2. Brit. Mus. ♂	3. Brit. Mus. ♀	4. Water- house.	5. N.S.W. ♂	6. Water- house.	7. S. Aus. ♂
Head and body	457	440	400	381	350	305	285
Tail	305	290	210	215	200	228	165
Hind foot	—	65	60	70	49	52	45
Ear	—	28	27	37	32	32	25

DIMENSIONS OF SKULL.

	Waterhouse.		Brit. Mus.	Waterhouse.		N.S.W.	South Australia.			
	♂	♀								
Length	79	75	75	74	73	72	64	58	56	55
Breadth	49	45	47	45	44	44	38	36	35	34
Length of nasals	32	28	31	26	25	29	23	20	20	19
Length of palate	46	41	45	41	41	41	36	35	33	32

From the absence of the hallux, and the granular surface of the palm and sole, we would imagine that *D. viverrinus* was by no means so strictly an arboreal animal as is *D. maculatus*. It was at home in a wide variety of habitats, and frequently took up its abode in the neighbourhood of human dwellings. It was abundant round, and even in the immediate precincts of, the larger Australian towns. Twenty years ago it was exceedingly common about Adelaide. Still more recently it lived close to Melbourne; and to-day it is not uncommon in the suburbs of Sydney. It inhabited treeless rocky country as well as the more cultivated

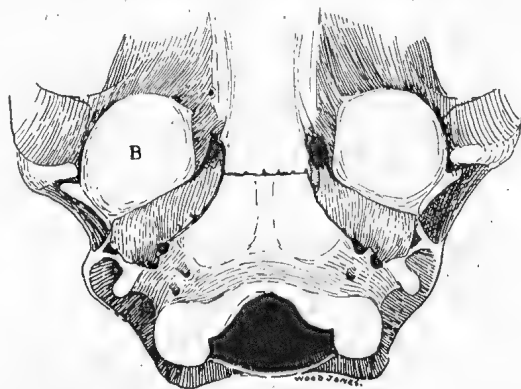


FIGURE 55.—Underside of the posterior end of the skull of *Dasyurus viverrinus*. The Bulla on the left side of the figure is marked B. Twice natural size. Compare with Fig. 51.

districts, and everywhere evinced a preference for dwelling around homesteads and in the immediate neighbourhood of chicken runs. Very early in the days of colonisation it was regarded with dislike because of the damage it did by killing poultry ; but there are many settlers who would now welcome its return in order to keep the mice plagues within check.

The Native Cat is an absolutely fearless animal, and one which possesses all the bold intelligence of the typical predatory carnivorous animal. It is an attractive creature in captivity, and is by no means difficult to handle and render familiar. Although it will kill and eat poultry, it is contented with far smaller game, and probably depends very largely upon insects as its main source of food. For the greater part of the day the animal sleeps with its ears folded down, and its activities commence only at dusk ; then, after a cautious approach, it springs upon any victim with astonishing rapidity, and kills, as a rule, by a bite across the back of the head. There is no doubt that as a destroyer of mice, rats, and young rabbits the Native Cat played an extremely useful part in Australian rural economy, and despite the fact that it was an occasional robber of hen roosts its presence was a real asset to the country.

Its range in South Australia was formerly very wide. On Kangaroo Island it appears to have been always more or less of a rarity ; but from the accounts of old wallaby trappers there seems to be no doubt as to its existence on the island. Since the snares set for the wallaby and the opossum are not particularly likely to capture a Dasyure, and as the animal's skin is of no commercial value, it is not impossible that its scarcity on the island is more apparent than real. By the South Australian Murray River natives it was known as Ng'rui Moch (many spots), and 30 years ago it haunted the shores of the river and lakes, being there very partial to a fish diet. To-day, if it exists at all in this State, it must be an animal of the utmost rarity. Although there is no doubt that the influences which have been at work in the general process of the extermination of the Australian fauna have operated to the full on the Native Cat ; it is possible that another factor has come into play during the final scene of its passing. The animal has been trapped, poisoned and persecuted throughout the country ; and yet if we turn to the case of the European weasel in New Zealand we may learn how little effect these means have on the extermination of an active and intelligent carnivore. The Native Cat, with its cunning and its activity, was well able to look after itself, despite the fact that it was an extremely easy animal to trap. Its rapid decrease started about the year 1900, and during that and the two following years the so-called " common " Native Cat practically disappeared from South Australia. Much the same thing happened in Victoria and in New South Wales, with the exception of the district immediately round Sydney. It would seem certain that some epidemic disease must have spread through the Dasyures, and that after a lapse of twenty years the remnant has not succeeded in re-establishing itself. In the Animal Protection Act of 1919 the Native Cat is not even mentioned. The evil or the good that it did has ceased to be a factor of any economic importance.

(3) **Black-tailed, or Geoffroy's native cat.***DASYURUS GEOFFROYI* (Gould, 1840)

In general size, form, and pelage very like the Common Native Cat; but distinguished by the less bushy tail, which becomes darker towards the tip, and by the presence of a small but distinct hallux. General colour olive grey with a tinge of rufous. Somewhat darker than *D. viverrinus*. The white spots are smaller and more numerous than in the typical *D. viverrinus*. Dorsal surface of the body, outer side of limbs and basal portion of the tail rufous grey, suffused with yellow, and pencilled with black. The chin, throat, underparts of the body and inner side of the limbs white. Face paler and greyer than the general body colour.

The tail is long, and not so bushy as in *D. viverrinus*, crested dorsally; its basal half dorsally, and fourth ventrally, coloured like the back; the end and the greater part of the ventral surface black. No spots are present on the tail. Ears large, the dorsal surface brown, but the edges both dorsally and ventrally white. The processus antihelcis is prominent. The rhinarium, eye, and vibrissae as in *D. viverrinus*.

Manus and pes brownish upon their dorsal surfaces. Manus with naked palms, granular. Pads as in *D. viverrinus*, without striations. Pes with a hallux some 5mm. in length, soles naked and granular. Pouch shallow. Nipples, 6 in number, in two crescentic rows. Skull in almost all features practically identical with that of *D. viverrinus*, but the two posterior palatal vacuities larger and more discreet.

DIMENSIONS.

	Brit. Mus. N.S.W.	Brit. Mus. Queensland.
Head and body	♂ 400	♀ 360
Tail	310	270
Hind foot.....	63	60
Ear	31	31

DIMENSIONS OF SKULL.

	S.A. ♂	W.A. ♂	W.A. ♀
Length.....	65.5	77	63.5
Breadth	45	50	41
Palate, length	39	46	39.3
Nasals, length	23	27	25

How common the Black-tailed Native Cat used to be in South Australia is a point upon which evidence is difficult to gather. A specimen is recorded in the British Museum Catalogue of 1888 as from South Australia, collected and presented by Sir George Grey, and another was in Gould's collection from the Murray. In 1896 the animal was living in the Northern Territory as recorded by Sir Baldwin Spencer. No specimen from South Australia exists in the South Australian Museum, nor is any mention of a specimen included in the record books of that

institution. Moreover, men who have been professionally interested in the fauna of the State for a period of forty years are unaware of any examples being taken in South Australia proper. Unless it still lingers near to the northern limits of the State, it must probably be regarded as extinct in South Australia.

The form of the species which lives in Western Australia is larger and darker, and is properly known as *D. geoffroyi fortis*. Thomas, 1906.

SUB-FAMILY II.—PHASCOGALINAE.

Division of the Sub-Family into Genera—

(A) Skull with the interorbital region broad and flat. Nasal bones expanded behind. Pes with striated pads at the bases of the digits. (See Figures 57 and 58).

(B) Hind feet with 5 digits.

C. Premaolars. $\frac{3-3}{3-3}$.

Genus 1. *Phascogale*.

C¹. Premolars. $\frac{3-3}{2-2}$.

Genus 2. *Chaetocercus*.

(B¹) Hind feet with 4 digits.

Genus 3. *Dasyuroides*.

(A¹) Skull with the interorbital region narrow and convex. Nasal bones not expanded behind. Pes with granulated pads at the bases of the digits. (See Figures 71 and 72).

(D) Hind feet with 5 digits. Bullae small.

Genus 4. *Sminthopsis*.

(D¹) Hind feet with 4 digits. Bullae large.

Genus 5. *Antechinomys*.

GENUS 1. PHASCOGALE (Temminck, 1825).

This Genus contains a series of small animals, mostly of slender, graceful build ; and generally not unlike the Tree Shrews and terrestrial Shrews among the Monodelphia. The rhinarium is naked and grooved. The ears are long and rounded. The tail is long ; but it is variable in its characters. The feet are comparatively broad and short. The hallux is present, but is small and devoid of a claw. The palms and soles are naked, and granular in texture. The pads at the bases of the digits of both manus and pes are striated. The pouch is reduced or absent. Nipples rather variable in number, ranging from 4 to 10. Dentition—I. $\frac{4-4}{3-3}$. C. $\frac{1-1}{1-1}$. PM. $\frac{3-3}{3-3}$. M. $\frac{4-4}{4-4}$. Carnivorous and insectivorous. Most species are capable of climbing, and some are semi-arboreal. The members of the Genus are known as a whole as Broad-footed Pouched Mice. Three species are recorded from South Australia.

KEY TO THE SOUTH AUSTRALIAN SPECIES.

I. External characters—

(A) Tail not crested. *Ph. flavipes.*

(A¹) Tail crested, ending in a terminal brush.

(B) General body colour and base of tail grey. *Ph. penicillata.*

(B¹) General body colour brownish, base of tail rufous. *Ph. calura.*

II. Cranial characters—

(A) Interorbital breadth greater than width of muzzle opposite last premolar. *Ph. flavipes.*

(A¹) Interorbital constriction less than width of muzzle opposite last premolar.

(B) Basal length of skull about 40mm. *Ph. penicillata.*

(B¹) Base of skull about 30mm. *Ph. calura.*

(1) Yellow-footed Pouched Mouse.

PHASCOGALE FLAVIPES (Waterhouse, 1837).

A sturdy, compactly built, rather rough-coated little animal of a general warm russet colour. Though remarkably variable in size, it may be said that the average specimen is comparable to a half-grown rat. The animal living in the Mount Lofty range of South Australia is a large representative of the species.

The fur is dense and crisp, the coat having a roughish wiry appearance, the stiff hairs of the outer coat standing out prominently. The typical South Australian animal is dark grizzled brown on the dorsal surface, rich tan brown below. The head is broad and flat; in colour grizzled by the intermixture of black hairs and light brown hairs. In front of the eye is a darker patch, and immediately

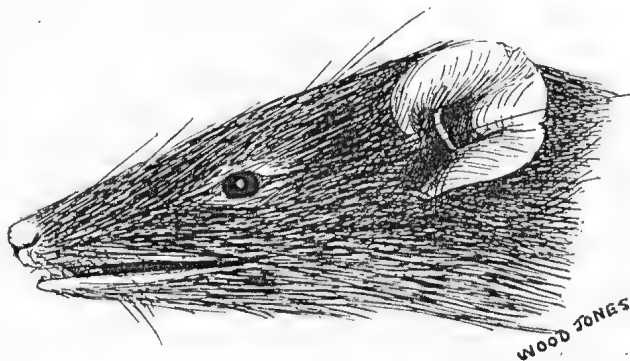


FIGURE 56.—Head of *Phascogale flavipes*. From a male specimen from Mount Lofty. One and a half times natural size.

above and below the eye the light hairs prevail, making two light eye-lid patches. A light area also runs along the upper border of the mouth. The general dorsal surface is of a grizzled tawny brown; the grizzled appearance being due to the dark brown hairs having light tips. The longer harsh hairs of the back average 11mm. in length. Upon the sides of the body the colour becomes a rich golden tan, an especially bright patch being present immediately below and behind the

ear. The chin and throat pale yellow. The whole of the ventral surface is bright tan, the bases of the ventral hairs being smoky grey. The outer surface of the limbs is like the general dorsal body colour, but more rufous; the inner side of the limbs is pure bright tan, dorsal surface of manus and pes reddish yellow, being a paler shade of the colour of the ventral surface of the body.

The tail is shorter than the head and body. Uniformly clothed with stiff hairs, bright rufous on the ventral surface at the base, and on the dorsal surface coloured like the body; becoming darker on all aspects towards the tip.

The ears are short; when laid forwards they only just reach the posterior angle of the eye (thereby differing from the description in the Brit. Mus. Cat., 1888):

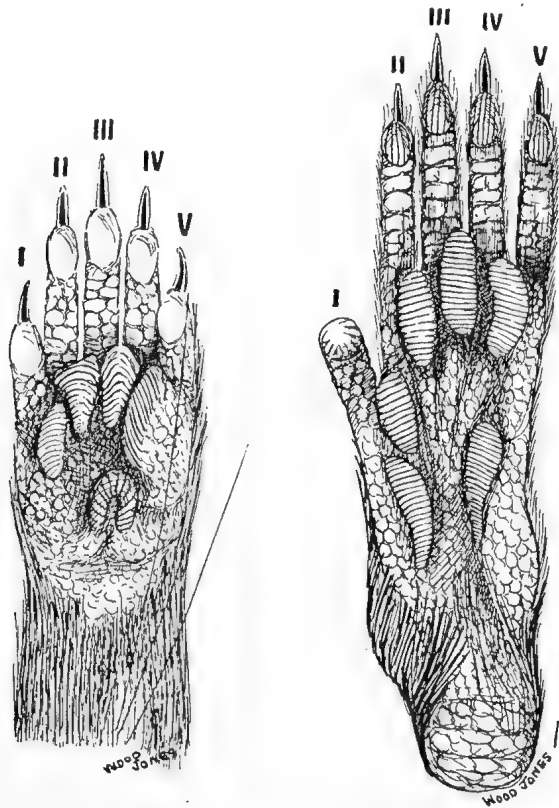


FIGURE 57.—Left manus and pes of *Phascogale flavipes*.
Four times natural size.

almost naked upon the dorsal surface, save for some fine short hairs along the anterior margin; the naked portion being covered by a tuft of hairs growing from the base. Within, are short fine hairs most prominent around the margins, and along the line on which the concha is folded during rest. The posterior margin is sinuous, being markedly concave opposite the line of folding. The processus antihelicis is large, rounded, and flat. (See Figure 56).

The rhinarium is naked, dark flesh-coloured and granular. It is cleft in its entire length. The eye is black, the eyelids being fringed by fine black hairs. The vibrissae are well developed. All the usual facial groups are present, and well represented. Many of the longer vibrissae are black at the base and pale towards

the tip. Those of the mystacial set measure 25mm. Upon the fore limb, the ulnar carpal and the medial ante-brachial are well developed and pale.

The manus shows a naked granular palm, with the typical striated pads, the thenar and the first interdigital pads being conjoined. The digital formula is $3 > 4 > 2 > 5 > 1$. (See Figure 57).

The sole of the pes is naked, save for some hairs which come beneath the fore part of the heel. There are six well developed pads, all striated. The digital formula is $3 > 4 > 2 > 5 > 1$. The hallux is clawless. (See Figure 57).

The skull (see Figure 58) in general form is broad and flat. The nasal bones are broadened at their posterior ends. The inter-orbital region is broad, smooth, and flat. The bullae are rounded, tympanic inflation well marked. The interorbital constriction is equal to or greater than the diameter of the snout at the level of the last premolar.

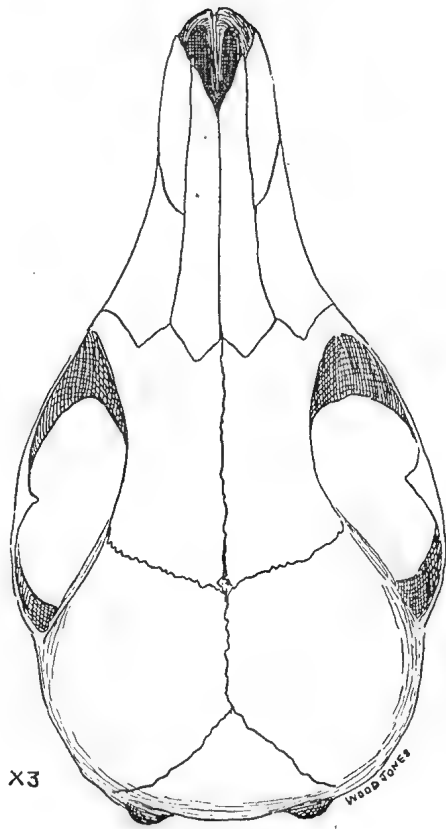


FIGURE 58.—Skull of *Phascogale flavipes* seen from above. Three times natural size.

DIMENSIONS.

	Mount Lofty.	Mount Lofty.	Mount Lofty.	Skin Brit. Mus. S.A.	Brit. Mus. S.A.
	♂	♂	♂	♂	♀
Head and body	148	144	140	c. 130	108
Tail	94	92	93	90	84
Hind foot	20	19	20	19	17
Ear.....	10 (15.5)	15 (19)	12 (17)	10	10.5

DIMENSIONS OF SKULL.

	Brit. Mus.	Humbug Scrub. S.A.
	♀	♂
Basal length	27	26
Breadth	16	16
Nasals, length	12	10
Intertemporal breadth	6.5	6.5
Palate, length	15.8	15
M ¹ — M ³	5.5	5.8

The Yellow-footed Pouched Mouse is an animal of great interest from a zoological point of view, since in the whole of its anatomy it shows itself to be a remarkably generalised animal. It represents a marsupial base form, its general anatomy

being but little modified from a basal mammalian plan, and it stereotypes the simple creature that could be considered ancestral to most of the marsupial radiations.

Though very rarely seen, it is probably still fairly abundant in suitable localities. It is a bush-haunting species. A useful insectivorous and carnivorous creature, it is too small and obscure in its ways to attract attention; and but for being occasionally brought into houses by cats it would usually escape notice. It lives at the present time in the Mount Lofty range; but it is much to be feared that

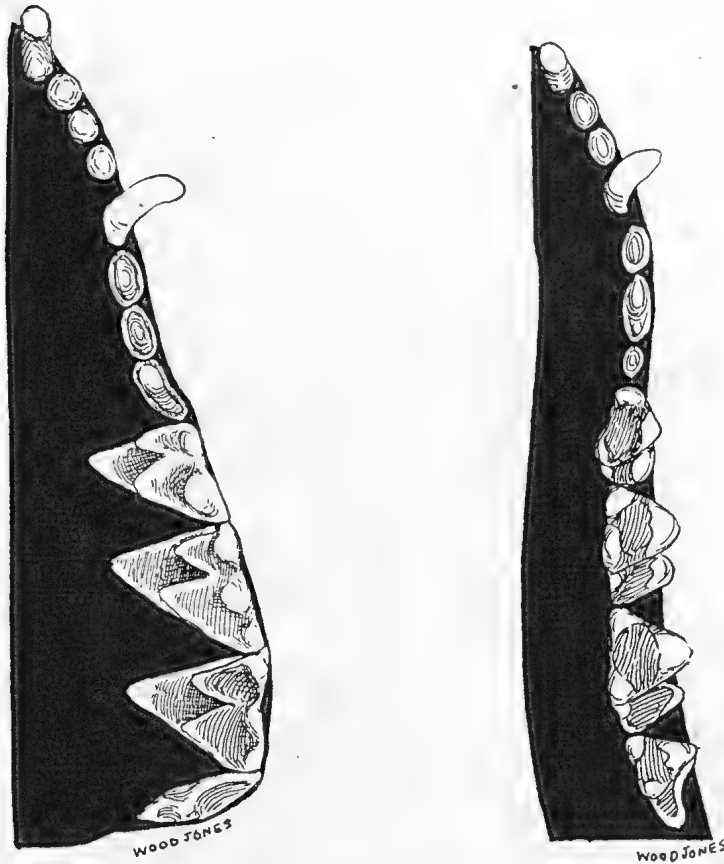


FIGURE 59.—Left upper and right lower teeth of *Phascogale flavipes*. Six times natural size.

cats will exterminate it wherever these destructive pets are free to work havoc among the native fauna. A form named *Phascogale flavipes leucogaster*, in which the ventral surface is white instead of tan, is found in North and Western Australia.

(2) Brush-tailed Pouched Mouse.

PHASCOGALE PENICILLATA (Shaw, 1800).

This species appears never to have had a popular name, although to a passing generation it was fairly familiar animal; in works on zoology it is usually termed the Brush-tailed Pouched Mouse.

One of the most beautiful of the little carnivorous Marsupials; its general appearance is that of a small, lightly built, grey rat; with a long tail terminating in a full silky black brush. (See Figure 60).

Though lightly built, and extremely graceful, it evinces strength and activity in every line of its lithe body.

The fur is fine and soft, the under-fur thick and dense. The long hairs of the outer coat of the dorsal surface are 20mm. in length. The general body colour is pale grizzled grey inclining to a more rufous grey upon the outer aspect of the fore limbs. The head, the general dorsal surface of the body, the outer surface of the limbs, and the base of the tail uniformly grizzled grey. Fore limbs somewhat more rufous than the general surface of the body. The chin, throat, ventral surface of the body and inner aspect of limbs passing from pale grey to creamy white. The dorsum of manus and pes grey, becoming white upon the digits. Crown of head



FIGURE 60.—*Phascogale penicillata*. From an adult male South Australian specimen. Half natural size.

grizzled grey, distinctly darker in the mid line. A darker patch extends through the mystacial region to the eye, and beyond the eye to the ear; the immediate area above and below the eye is distinctly lighter than the general colour of the rest of the head and face. (See Figure 61).

The tail is long, its basal fifth is clothed in the whole of its circumference with fur of the general body colour and texture. The next portion, again amounting to about a fifth, is short haired; the hair upon the dorsal surface being cream grey and considerably lighter than the dorsal surface of the body; the ventral surface

is clothed with chocolate brown hairs which are continued further towards the tip of the tail as a narrow median crest. The terminal three-fifths consist of a beautiful silky brush of black shining hairs; the hair being uniformly distributed around

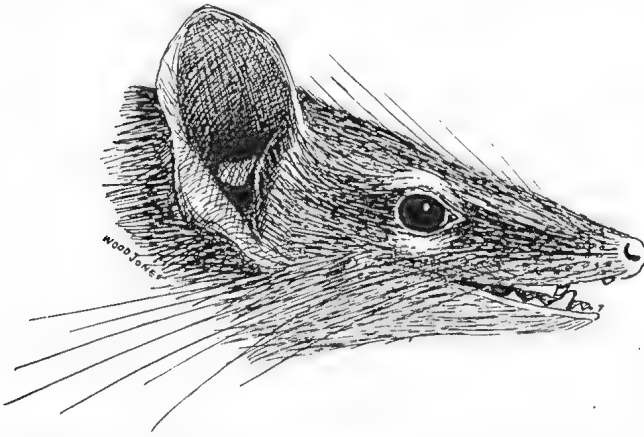


FIGURE 61.—*Phascogale penicillata*. Characters of the head from a male specimen taken in the Mount Lofty Range. Natural size.

its circumference. The terminal tuft extends 30mm. beyond the tip of the tail, and the long hairs of the fullest portion of the brush measure 40mm. The ears are large, laid forward they cover the eyes. They are thin and membraneous and almost naked; very fine pale hairs are distributed along their margins and along the inner surface over the line where the concha is folded during

repose. The processus antihelicis is prominent. The rhinarium is naked, granular, dark flesh-coloured, and grooved in the whole of its extent. The eye is dark brown fringed by a row of short fine black eyelashes. The mystacial set of vibrissae is disposed in 5 or 6 rows; the individual hairs are fine, black in colour and the longest are 40mm. in length. Two black hairs spring from the supraorbital papilla, one of these is 20mm. long, and the other only a little more than half that length. The genal tuft contains both light and dark vibrissae of which there are 6 or 8, the longest measuring 45mm. The submental group is not well defined, and consists of short pale hairs increasing in length posteriorly, till they merge with the interrampal set which consists of 2 or 3 white bristles. The ulnar carpal set is particularly well marked, and contains 6 or 8 strong white vibrissae 30mm. in length. There are 2 well developed anconeal vibrissae 20mm. long and white in colour.

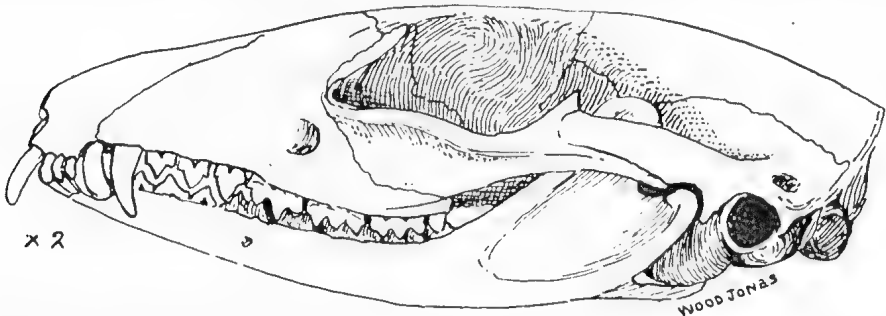


FIGURE 62.—*Phascogale penicillata*. Skull of a male South Australian specimen. Twice natural size.

Manus; with the palms naked, granular, and flesh-coloured. The digital formula is— $3 > 2 > 4 > 5 > 1$. Apical pads are well developed. Four well developed elongated interdigital pads, which are finely striated. Thenar and 1st

interdigital pad partly confluent. Hypothenar pad large, striated and crescentic in outline. Pes hairy beneath heel, rest of sole naked, granular, flesh-coloured. Digital formula— $3 = 4 > 2 > 5 > 1$. Hallux clawless. Three elongated, striated, interdigital pads. Thenar and first interdigital pads conjoined. Hypothenar pad elongated; finely striated. All digits but the hallux armed with strong curved claws. Hair is continued to the termination of digits.

Pouch but little developed, but the area of the marsupium marked by light tipped brown hairs of a texture different from that of the general body hair. Nipples 10.

Skull stoutly built, with a flattened brain case and a short conical muzzle (*see* Figure 62). Interorbital constriction considerably less than the diameter of the muzzle at the level of the last premolar.

Bullae rounded; tympanic inflation well marked.

DIMENSIONS.

	Brit. Mus. West. Aust. ♂ Adult.	Mount Lofty. ♂ Adult.	Mount Lofty. ♂ Adult.
Head and body	240	210	210
Tail	225	200	200
Hind foot	42	36	36
Ear	24	24	25

DIMENSIONS OF SKULL.

	Brit. Mus. South Aust. ♀ Adult.	Mount Lofty. ♂ Adult.
Basal length	45	43
Breadth	29	29
Nasals, length	17.3	17
Intertemporal breadth	8.3	8.5
Palate, length	26	25
M ¹ - M ³	9.2	10

Though once a familiar animal to settlers whose homes were in the more wooded districts, *P. penicillata* is unknown to the rising generation of country people. In habit it was predominantly a bush-haunting species; an active climber with the reputation for singular blood-thirstiness. It seems astonishing that so small an animal could ever have been a real menace to the poultry run of the settler, and yet it is credited with being a determined slayer of chickens, and one which killed not merely to appease its appetite. Many of the older residents in South Australia have caught the animal red-handed, and as with the Native Cat, it seems a remarkable thing that so well equipped a carnivore should have been reduced to a condition bordering on extinction in so comparatively short a time. What its range within the State may have been is difficult to determine. It was not met with by the Horn Expedition, but an animal which answers very much to its description, but of which no specimen is available, apparently exists over a wide area in the Centre. By the South Australian Murray River natives it was well known under the name of "Pundi" but it has not been seen in their district for very many years.

(3) Lesser Brush-tailed Pouched Mouse.

PHASCOGALE CALURA (Gould, 1844).

In general build resembling *Ph. penicillata*, but considerably smaller. Fur soft and fine, nearly wholly composed of under-fur. General colour a delicate, but warm ashy grey. Head greyish; back of body and outer side of limbs rufous grey, the rufous tinge increasing towards the sides of the body. Chin, throat, chest, ventral surface of the body and inner side of the limbs white; the line of demarcation between the ventral and the dorsal colouration being fairly distinct. Ears large, almost naked; the naked portion being partly concealed by tufts of rough hair springing from the base. Manus and pes white. Tail long. The basal portion clothed by short bright rufous hairs above, and below being dark brown. The terminal half clothed with a uniform black brush, the brush being somewhat less developed than in *Ph. penicillata*. Soles and palms naked. Pads well developed and striated. Skull as in *Ph. penicillata*, but smaller.

DIMENSIONS.

	Brit. Mus. From Adelaide.	Alice Springs.
Head and body	♂ c. 125	♂ 135
Tail	147	147
Hind foot.....	24	24
Ear	20	23

DIMENSIONS OF SKULL.

Basal length	29.6
Breadth	19.5
Nasals, length	9.6
Intertemporal	6.8
Palate, length	17
M ¹ - M ³	6.3

The measurements given in the British Museum Catalogue of 1888 are taken from an Adelaide specimen, but I have failed to trace any recent records of the animal in South Australia. In 1896 Mr. Gillen captured one at Alice Springs, and Sir Baldwin Spencer noted at the time that it was "evidently not a common form in the central districts." To-day it is impossible to define its former range in the State, or, unfortunately, even to attest to its present existence.

GENUS 2. CHAETOCERCUS (Krefft, 1866).

The pouched mice included in this Genus are terrestrial forms, which live in a typical desert habitat. They are small robustly built animals with shorter muzzles, shorter limbs, and shorter ears than the more arboreal members of the genus *Phascogale*. The tail is crested on its dorsal surface. Striations on the pads are reduced and are present only on the pes, the pads of the manus being smooth. Dentition--I $\frac{4-4}{3-3}$. C. $\frac{1}{1}$. P.M. $\frac{3-3 \text{ or } 2-2}{2-2}$. M. $\frac{4-4}{4-4}$.

The last upper premolar is single rooted and very small ; it is very commonly entirely wanting.

There are only two members of the Genus, and both are recorded in the fauna of South Australia. The two species differ only in their coat colour :—

(A) Dark form ; the original species described by Krefft. *C. cristicauda*.

(A¹) Pale form ; named by Oldfield Thomas. *C. hillieri*.

(1) **Crest-tailed Pouched Mouse. Krefft's Pouched Mouse.**

CHAETOCERCUS CRISTICAUDA (Krefft, 1866).

By the natives about Ooldea Soak named "Mulgara," and to the natives of Charlotte Waters known as "Amperta."



FIGURE 63.—*Chaetocercus cristicauda*. From a female specimen. Three-quarters natural size.

A sturdily built, short limbed, compact little animal. The head is somewhat flat, and the muzzle is more blunted than in most of its allies. The coat is fine and soft, mostly consisting of under-fur, which on the dorsal surface is slate grey at the base and bright brown at the tips. General colour varying from soft buff to bright red brown, becoming warmer and brighter upon the back. Hairs of the mid dorsal region measuring 10mm. Face light brown, brighter round the eyes and along

the upper lip. Outer side of limbs sandy coloured. Chin, throat, ventral surface of the body and inner side of the limbs creamy white or pure white. Manus and pes white.

Tail shorter than the head and body; it is thickened, the thickening starting

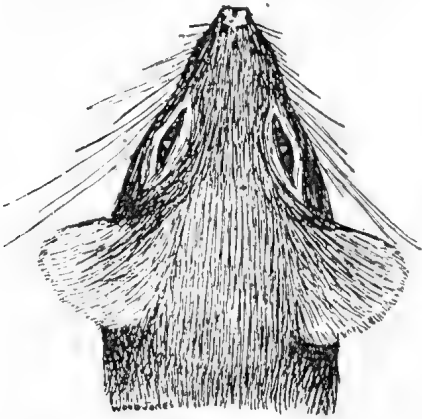


FIGURE 64.—*Chaetocercus cristicauda*. Head of a male specimen viewed from above. Three-quarters natural size.

almost at the base, and extending for some two-thirds of the total length of the tail. Root of the tail clothed by a continuation of the red-brown body hairs. Immediately following this basal portion of the tail, the proximal, and swollen, portion is clothed by short, closely adpressed hair of a bright fox red colour. The terminal tapering half of the tail is ornamented with a large dorsal, and a small ventral crest of shining black hairs. The ventral crest is inconspicuous, and consists of short stiff hairs which do not increase in length as they are followed towards the tip of the tail.

The dorsal crest consists of long hairs which, starting as a mere ridge of fine black hairs, increases in length towards the tip of the tail and constitutes a fine fin-like crest.

The ears stand well away from the head and are rounded in outline. In colour they are slightly paler than the general body tint. The outer surface is clothed by fine creamy or sandy hairs. When the ear is laid forward it fails to reach the posterior angle of the eye. There is a single processus antihelicis.

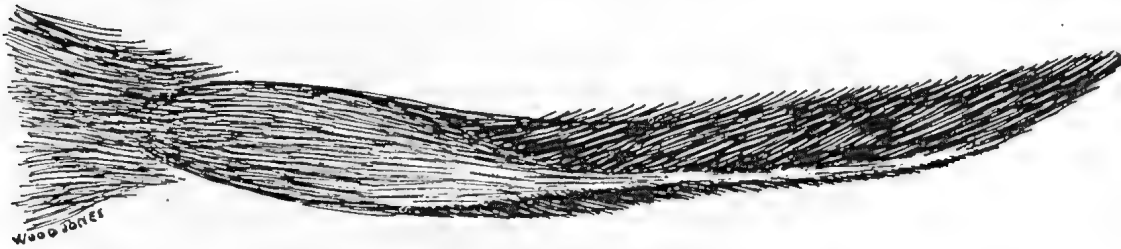


FIGURE 65.—*Chaetocercus cristicauda*. Lateral view of the crested tail. Natural size.

The muzzle is not so pointed as in the other Pouched Mice. The naked rhinarium is finely granular in texture, and pale brown in colour. It is deeply cleft in the mid line, the cleft being continued to the upper lip, and to the dorsal surface of the naked area. The nostril is cleft laterally.

The eye is surrounded by a pale area of hair. The eyelashes are dark, and better developed upon the upper than upon the lower lid. The eye is black and rather large.

There are four rows of mystacial vibrissae: the individual hairs are black, but, when elongated, the tip is pale; the longest measure 33mm. The supraorbital

set contains only 1 or 2 short dark bristles. From 4 to 6 long pale vibrissae spring from the genal tubercle. The submental set is represented by a few pale hairs, and 3 long white vibrissae spring from the interramal papilla. The ulnar carpal vibrissae are well marked, and 2 long (18mm.) and 2 short bristles are present.

The palms of the manus are naked, granular, and almost white in colour. There are 5 well-developed pads and a sixth (proximo-radial) less distinct. The pads are granular. Each pad has a central specialised granule (not so well marked in the proximo-radial pad) which marks the contact point of the pad, and which is surrounded by the smaller uniform granulations of the palm. The central granules

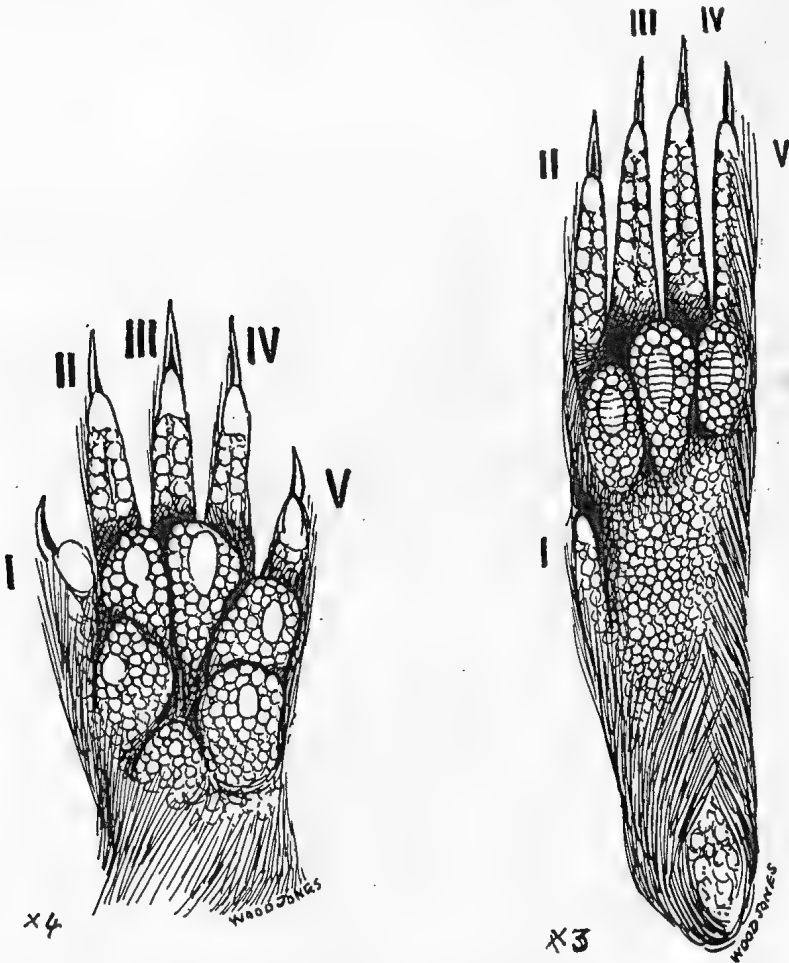


FIGURE 66.—*Chaetocercus cristicauda*. Left manus and pes. Manus four times, pes three times; natural size.

are plain; there being no striations or punctures upon them. The digital formula is $3 > 4 > 2 > 5 > 1$; digits 2 and 4 being almost equal. Apical pads are present on the digits and they are unstriated.

The soles of the feet are naked in their anterior portion and hairy towards the heel. The naked portion is granular. There are three well developed pads. Each

pad is granular; but, as in the palm, there is a definite central area marked out on the pad. In the sole this central area is sculptured by fine transverse striae. This species has always been described as being distinguished by having unstriated pads, but no specimen that I have examined has failed to show the presence of

definite striations on the pads of the sole (see Figure 66). The digital formula is $4 > 3 > 5 > 2 > 1$; digits 3 and 5 being almost equal. The hallux is small, but remarkably variable in its degree of development, and possesses no claw. Apical pads are unstriated. The pouch in the quiescent state is practically obsolete. Nipples from 6 to 8.

The skull is stoutly built, being broad and flat in general contour. The bullae are large and rounded, mastoid inflation being particularly well marked. The upper central incisor does not project forward: it is separated by about its own diameter from the tooth next behind it. The last upper premolar when present is a minute tooth (see Figure 67). The first upper premolar is also at times reduced to a mere rudiment.

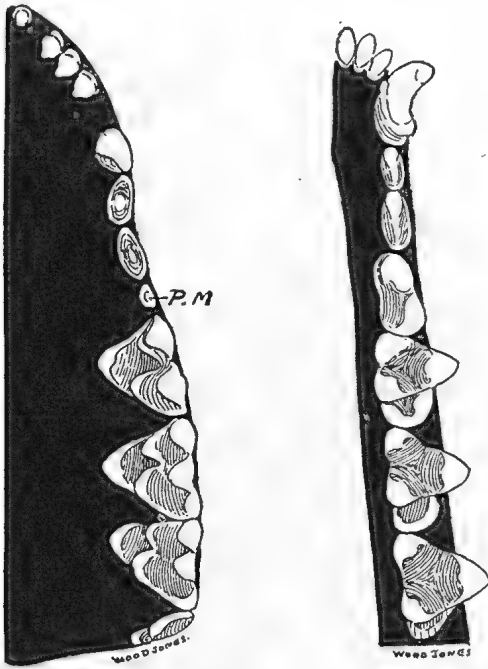


FIGURE 67.—Upper left and lower right teeth of *Chaetocercus cristicauda*. Four times natural size. The small upper third premolar (P.M) is present in this specimen. In some specimens the first premolar is equally reduced.

DIMENSIONS OF SKULL.

	Spencer.	Ooldea.
Basal length	♀ 34.5	♂ 35
Breadth	23.5	24
Nasals, length	12	12
Palate, length	18	18
M ¹ - M ³	7.5	8

The size to which the animal grows is extremely variable, a condition which is familiar in several of the small species living in the Centre. But apart from the general size, the actual proportions of different parts of the body manifest a strange variability in different individuals, an extended series of measurements is therefore appended; the first from Sir Baldwin Spencer's specimens from Charlotte Waters; the second from my own from Ooldea, where they were collected by Mr. A. G. Bolam. [NOTE.—The method of measuring the ear is different in the two series.]

Sex of Specimen.		Head and Body.	Tail.	Hind Foot.	Ear.
1	♂	220	126	35	18
2	♀	170	98	30.5	16
3	♀	168	110	30.5	17
4	♂	148	89	26	15.5
5	♂	144	93	28	15
6	♀	138	86	25	13.5
7	♂	136	83	27	14
8	♀	135	86	26	15
9	♀	135	88	26	18 ?
10	♀	135	84	27	17
11	♀	132	85	25	14.7
12	♀	130	85	28	15.5
13	♀	130	85	26	14
14	♀	130	86	26	15
15	♀	128	89	27	14.5
16	♀	125	93	26	14
17	♂ Not adult	91	67	22.5	15
18	♀	86	51	20.5	12
1	♂	180	92	31	25
2	♂	180	80	27	21
3	♂	170	102	30	24
4	♂	170	85	28	20
5	♀ With 7 embryos	160	93	26	20
6	♂	155	100	29	23
7	♀	155	75	25	18
8	♀ With 7 embryos	150	84	27	20.5
9	♀	130	82	23	28
10	♂	125	74	24	15

Krefft's Pouched Mouse has an interesting history. It was originally described in 1866 from a South Australian specimen which was preserved in the Australian Museum, Sydney. The original specimen was in very poor condition, and several details of importance were lacking, or given inaccurately, in the first published description. Thirty years passed before fresh specimens were examined, and then, in 1896, the animal was again brought to light by the Horn Expedition, and an extended description of the species was given by Sir Baldwin Spencer. It is a typical desert animal, one which is well known to the blacks, and probably not uncommon in good seasons in the Centre. Like all the fauna of the Centre its numbers are subject to the most remarkable fluctuations; and so also is the size at which it attains maturity. It is the animal which on several occasions has multiplied in an astonishing manner during the passage of a mouse plague across Central Australia. At these times its services are of the greatest value, and in the mouse plague of 1905, although no human ingenuity could check the increase of the mice, the appearance of these active little carnivores cleared them from certain districts in a remarkably short time.

The Mulgara is an absolutely fearless animal, and beyond doubt it is one of the most intelligent of the marsupials. Those that I have had in captivity have shown the most trusting boldness: they will come confidently to the hand, and although for their size one of the most efficient carnivorous forms, they make no attempt to bite unless molested. They will thrust their noses against the wire of their run right into a cat's face, and this through no stupidity on their part, for both by vision and by scent they are perpetually well informed of their surroundings. A large

and active mouse introduced into the cage of a *Mulgara* is killed in a flash if the animal is hungry ; but if its appetite is appeased it will freely allow the mouse to occupy its bed until such time as it requires a meal. When hungry, its methods of mouse hunting are remarkable. Regarding its victim for a second, the whole animal becomes rigid, its tail quivers in true lizard fashion, and with a lightening stroke it seizes the mouse across the back of the head and, practically with the stroke, the mouse is dead.

Despite cramped quarters and strangeness of surroundings, I have never seen the *Mulgara* bungle the business : one rush, one stroke delivered in a flash, a bulldog hold and thing is over. After this remarkable exhibition of precision in killing the *Mulgara* usually attends to its toilet before proceeding further ; for in all things it is a remarkably dainty and clean little animal.

The operation of eating a mouse is carried out in a most methodical manner. The start is always made with the tip of the nose. The skin is separated and turned back. The skull is crushed, the brain devoured, and the body is eaten from head to tail, often without the production of a single laceration of the skin. A rat which provided a meal for three hungry *Mulgaras* was skinned almost as neatly as though a skilled taxidermist had been at the work. No bones were left attached to the hands and feet, the skin was turned completely inside out and was practically perfect.

Although a mouse or a bird is always killed in a lightning rush, considerable caution is displayed in dealing with certain beetles, and it is a remarkable thing that all insects that are not instantly recognised, and killed by biting, are taken in the hand before being transferred to the mouth. Most beetles are caught in the hand, and the utility of the manus for searching out and picking up insects which cannot be seized by the jaws is truly remarkable. Although such bloodthirsty little animals, they do not quarrel among themselves, and they may be placed together in a cage regardless of sex or acquaintance ; in this respect they differ remarkably from several less carnivorous marsupials. They will not kill a sickly fellow, nor will they devour its body when dead ; but they vacate the nest in which a dying comrade is lying, and do not molest it in any way. They appear to be extremely affectionate little animals, and they are fond of lying in the sun with their heads on each others backs. They are by no means nocturnal, being lovers of the sunlight, and having a truly lizard-like habit of lying perfectly flat in the hot sunshine. The degree of heat and the intensity of sunlight they delight in is very astonishing in a mammal. Particularly reptilian is their method of flattening their bodies whilst basking, and so too are the rapid quivering of the tail, and the short sharp movements of the limbs as the animal exposes itself to the direct rays of the sun. There is also something remarkably reptilian in their vitality. Those that I have had for long in captivity have all arrived from the Centre in a condition which could fairly be described as "dead." All were cold and apparently lifeless after their long winter railway journey from Ooldea ; but these apparently dead animals have proved easy to resuscitate by heat and artificial respiration.

The breeding season (at Ooldea) is from June to September, and seven seems to be the usual litter. The pouch is practically absent ; but when the embryos are small they are more or less protected by a shallow ridge of integument which

marks the sides of the pouch area. When the young have grown larger they depend from the nipples unprotected by any skin fold of the mother's ventral surface. It is a curious thing to see a mother, with seven large foetuses clinging to the nipples, staggering about in search of insects or in combat with mice. The time spent by the young on the nipples is considerably over a month. The animal appears to have a wide distribution in the Centre, and although like most carnivores it is not usually at all abundant it is capable of rapid increase during good seasons. For all my specimens, living and dead, I am indebted to Mr. A. G. Bolam, of Ooldea.

(2) Hillier's Pouched Mouse.

CHAETOCERCUS HILLIERI (Thomas, 1905).

This species was described from a single skin (without skull) from Killalpaninna : it was named after its discoverer, Mr. H. J. Hillier, an authority on the Aranda natives. The specimen differs from *C. cristicauda* in being considerably paler in colour. It must be pointed out that *C. cristicauda* is a very variable animal, and specimens which are considerably lighter than usual are often captured with the more normal coloured individuals.

DIMENSIONS OF THE TYPE SPECIMEN (♂).

Head and body	150
Tail	100
Hind foot	30
Ear	27

Unless further specimens from Cooper's Creek should show this type to be constant, with perhaps some cranial distinctions, we might be disposed to regard it as merely a pale variety of the older species.

GENUS 3. DASYUROIDES, (Spencer, 1896).

This Genus was created for the reception of one of the most interesting animals discovered by the Horn Expedition to Central Australia. The generic characters present a strange mingling of features distinctive of nearly allied Genera.

The general form of the body closely resembles *Chaetocercus* ; the same sturdy short-limbed build characterises both animals, and their general similarity is striking.

The pes has only four digits, and in the absence of the hallux an approximation is made to some of the members of the Genus *Dasyurus*. The soles of the feet are hairy, and in this feature there is a resemblance to some of the Narrow-footed Pouched Mice of the Genus *Sminthopsis*.

The marsupium is shallow, and the nipples are 6 in number. The skull in general is as in the Genus *Phascogale*, but the nasal bones are only very slightly expanded behind and thereby resemble those of *Sminthopsis*.

The dentition is I. $\frac{4-4}{3-3}$. C. $\frac{1-1}{1-1}$. P.M. $\frac{3-3}{2-2}$. M. $\frac{4-4}{4-4}$; in this respect resembling *Chaetocercus*.

The animals are desert living creatures, dwelling in burrows on the stony table-lands. Nocturnal in activity ; carnivorous and insectivorous.

Byrne's Pouched Mouse.

DASYUROIDES BYRNEI (Spencer, 1896).

Named after Mr. P. M. Byrne, of Charlotte Waters, who obtained the original specimens.

Form, stout and strong; fur, close and soft, mainly composed of under-fur. General colour a grizzled grey, with a faint rufous tinge, especially on the head and back. Chin, ventral surface, inner side of limbs and upper surface of manus and pes white. Tail rufous coloured in rather less than its basal half, the hair being fairly long. The terminal half is thickly covered all round with long black hairs, which form a very well marked dorsal and ventral crest. The tail is fairly thick, but not incrassated.

The ulnar carpal vibrissae are well developed; 5 or 6 in number, the longest measuring 42mm. Ears naked above. Laid forward they reach nearly to the front of the eye.

Manus with naked palms; 5 well marked and faintly striated pads on granular elevations. Pes with comparatively narrow soles. The median part of the sole naked and granular, a close set series of hairs directed towards the mid line covers each side of the sole.

Pouch very slightly developed, marked by two low lateral folds. Nipples 6.

Skull somewhat strongly built. Muzzle short and broad. Nasals very slightly expanded posteriorly. Interorbital space fairly broad. Bullae very large and rounded, their mastoid portion much inflated.

DIMENSIONS (Spencer).

	♂	♂	♀	♂	♂	♂
Head and body	182	175	175	170	166	165
Tail	130	138	132	134	131	140
Hind foot	38	37	37	37	38	38
Ear	18	21	20	23	21	20

DIMENSIONS OF SKULL.

Basal length	37.2
Breadth	24.2
Nasals, length	13.5
Intertemporal	8
Palate, length	21
M ¹ - M ³	9

Obtained from Charlotte Waters. The above account is taken mainly from Sir Baldwin Spencer's description of the animal.

At Killalpaninna, on Cooper's Creek, a rather smaller and paler variety occurs, and this form has been distinguished by Oldfield Thomas (1906) as *Dasyuroides byrnei pallidor*.

GENUS 4. SMINTHOPSIS (Thomas, 1887).

In this Genus are included certain little animals usually known as Pouched Mice, which differ from the Pouched Mice included in the three preceding Genera mainly in possessing feet which are longer and narrower, and upon the soles of which are granular, not striated, pads. They are mostly slender and delicately built little

animals of a general shrew-like aspect. The ears are large and rounded. The rhinarium is naked, finely granular and deeply cleft in the mid line. The tail is well developed and short-haired. The pouch is more developed than in the Broad-footed Pouched Mice of the Genus *Phascogale*. Nipples 8-10. Dentition I. $\frac{4-4}{3-3}$; C. $\frac{1}{1}$; P.M. $\frac{3-3}{3-3}$; M. $\frac{4-4}{4-4}$.

The Narrow-footed Pouched Mice, as their long feet and granular pads suggest, are terrestrial animals. They are mostly nocturnal in activity and insectivorous in diet. The Genus is represented by several species which seem to show much variability and which are therefore by no means easy to determine.

Probably at least four species live in South Australia; but a great deal more work must be done in the way of systematic collecting in the Centre before any certainty regarding the distribution of these little animals is arrived at. Two of the species included here have been taken at Charlotte Waters, but almost certainly their range extends into South Australia proper. Species, such as *S. psammophilus*, which have not yet been recorded further south than the Lake Amadeus region are not included here.

KEY TO THE SOUTH AUSTRALIAN SPECIES.

- (A) Tail variably incrassated at the base.
 - (B) Pes with definite pads, hairy only under the heel.
 - (C) Tail shorter than the head and body.
 - S. crassicaudata.*
 - (C¹) Tail longer than the head and body.
 - S. larapinta.*
 - (B¹) Pes without definite pads, hairy throughout.
 - S. hirtipes.*
- (A¹) Tail not incrassated at base.
 - S. murina.*

(1) Fat-tailed Pouched Mouse.

SMINTHOPSIS CRASSICAUDATA (Gould, 1844).

A very small mouse-like creature. A savage and alert-looking little animal with



FIGURE 68.—*Sminthopsis crassicaudata*. Adult female specimen. Natural size.

a general resemblance to the shrews of the Northern Hemisphere. Tail notably thickened (see Figure 68). Fur fine and soft, almost entirely composed of under-fur. General colour grizzled grey, becoming browner on the back. Individual hairs slate grey at the base and brown at the tip. Dorsal surface of the muzzle and face paler than the body. A variably marked dark stripe runs along the muzzle and passes through the region of the eye towards the ear (see Figure 69). Above and below this line, the face is rather more yellowish brown than the general body colour. Tail a uniform greyish, paler than the body. Chin, chest, and ventral surface greyish white. Manus and pes white.

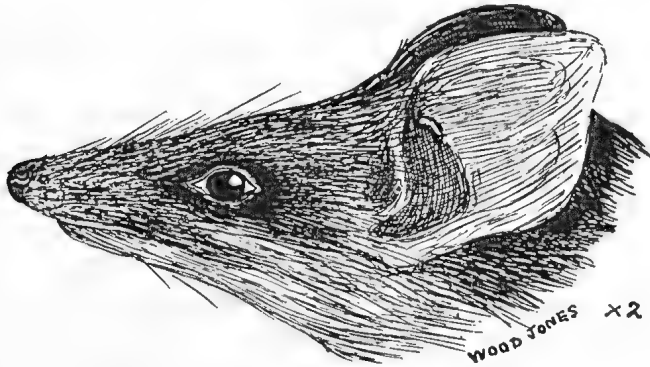


FIGURE 69.—*Sminthopsis crassicaudata*. Head of an adult female South Australian specimen. Twice natural size.

Tail shorter than the head and body; thickened, the maximum girth of the thickened portion being somewhere near the middle of the length of the tail, tapering both towards the base and the tip. The degree of thickening, and the total length of the tail are subject to wide variation.

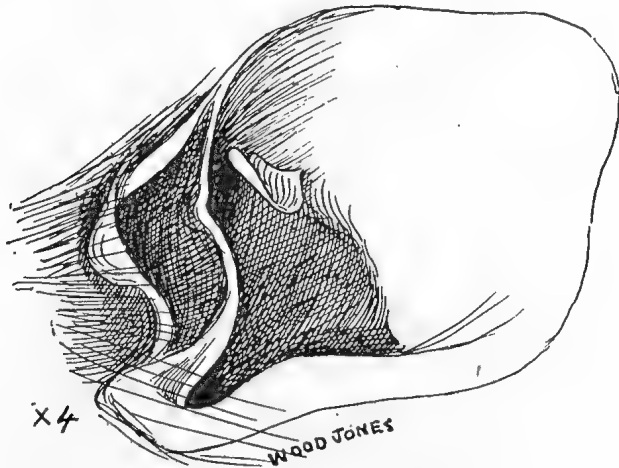


FIGURE 70.—*Sminthopsis crassicaudata*. Left ear. Four times natural size.

The tail is covered with fine scales and clothed with short, stiff, pale hairs. Ears very large and pointed. Laid forwards they reach at least half way between the tip of the snout and the eye. Inner surface with only a few pale hairs along the

margins. Margins of ear pigmented, and darker than central portion. Outer surface of ear very boldly marked; anterior portion pigmented, and clothed with fine short brown hairs; central portion yellowish and practically naked; hinder portion slate grey, and giving rise only to pale fine short hairs. A tuft of long hair is present at the base of the central yellow portion of the dorsal surface of the ear. Processus antiheliceis is large and only partially folded (see Figure 70). Muzzle sharply pointed. Rhinarium dark flesh-coloured; granular; deeply grooved below. Nostrils cleft at their lateral margins. Eyelashes fine and dark; the eye

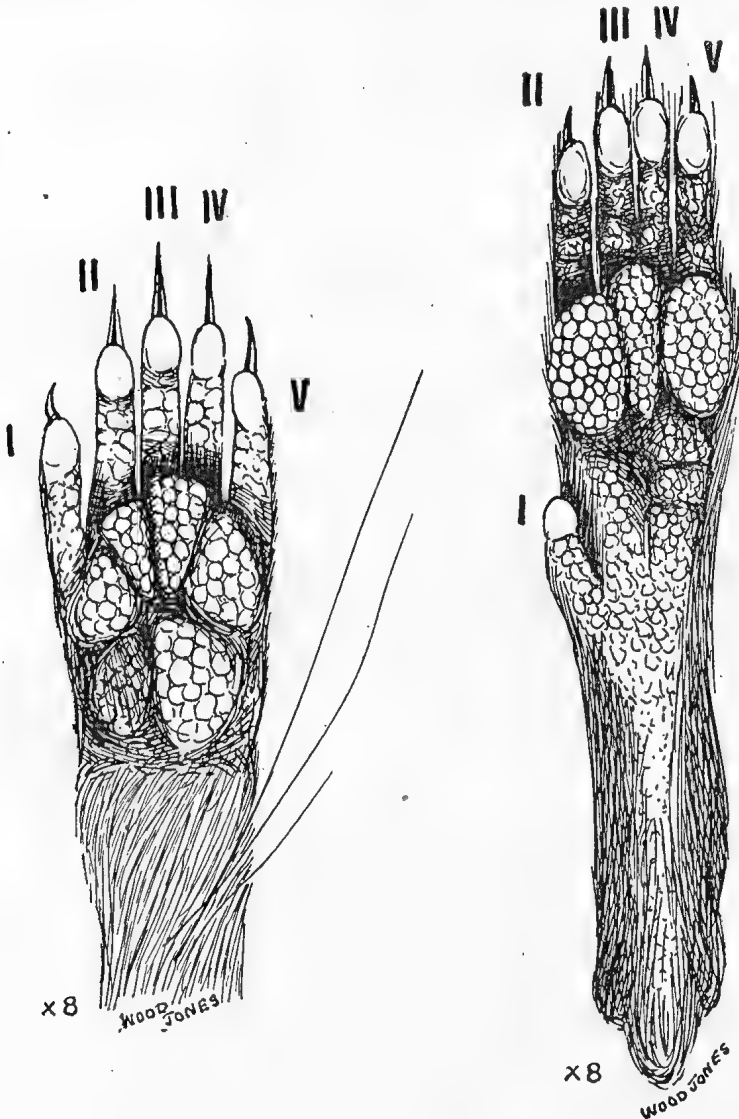


FIGURE 71.—*Smynthopsis crassicaudata*. Left manus and pes. Eight times natural size.

is black; the pupil circular. There are four rows of mystacial vibrissae; two (one long and one short) supraorbital; one long genal; and four short interramal.

All the facial vibrissae are dark in colour. There are two or three long pale ulnar carpal vibrissae.

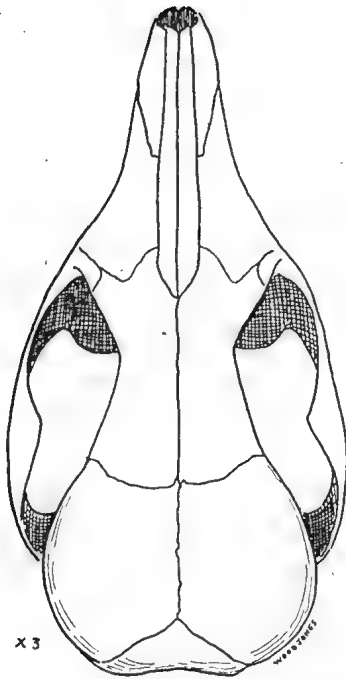


FIGURE 72.—Skull of *Sminthopsis crassicaudata* seen from above. Three times natural size.

The manus with naked, granular, flesh-coloured palms. Five well-developed granular pads, and a sixth (proximo-radial) less distinct.

Digital formula $3 > 4 > 2 > 5 > 1$; digits 3 and 4 being almost equally prolonged. Apical pads present on all digits, unstriated.

Pes with soles naked in mid line over almost the whole of their extent; hairy at the sides and around the heel. Soles granular, flesh-coloured. Three well-developed granular pads at the bases of digits 2, 3, 4, and 5. No halluxal pad. Digital formula $4 > 3 > 5 > 2 > 1$. Hallux small and clawless. Apical pads present, unstriated. (See Figure 71).

Pouch well-developed, nipples varying from 6 to 10.

Skull very lightly and delicately built. The interorbital constriction narrow. The nasal bones unexpanded at their posterior ends. (See Figure 72).

DIMENSIONS.

As this little animal is exceedingly variable in size and proportions an extended series of measurements is given. It may be said in general that the form of the species living in the southern portion of the State is a large, long-eared, short-tailed type, with feet considerably less hairy than is usual in specimens from the more arid districts.

	The Adelaide District.		The North-East.		The North-West.
	♀, 6 young.	♂	♀, 5 young.	♀	♀, 6 young.
Head and body	110	100	85	66	90
Tail	58	47	60	55	60
Hind foot	15	15	15	15	14
Ear	23	19	15	14	17

	The Centre (Baldwin Spencer).						Queensland. (Brit. Mus.)	Victoria. (Brit. Mus.)
	♀	♀	♀	♀	♂	♀	♀	♂
Head and body ..	91	89	85	84	82	80	75	85
Tail	73	56	69	71.5	75	73	52	53
Hind foot	15	15.5	16	15.5	15.5	15.5	14.5	14.6
Ear	19	15.5	16	14.5	17	14.5	12.5	14

DIMENSIONS OF SKULL.

	N.S.W. Brit. Mus.	Brit. Mus.	South Aust.
Basal length	23.5	♀ 21.8	♀ 24
Breadth	14.5	13.3	14
Nasals length	9	8	9.5
Intertemporal	5	4.3	5
Palate, length	13.3	12	15
M ¹ - M ³	4.9	4.6	5

This little animal has possibly as wide a distribution as any Marsupial within the State. It is nowhere abundant, and its numbers in any given locality obviously depend upon season. It extends far into the salt-bush country, and is as much at home in the Centre as it is in the more wooded coast districts. It leads an obscure but useful life, and is usually brought under human notice by being carried into the house by domestic cats. Apparently, though readily caught and killed by cats, it is not a very acceptable article of diet, and several specimens have been obtained which, having been captured and played with, have been abandoned. The females appear to vastly outnumber the males, or else to fall more easy victims to cats and traps, and the measurements of only three males are included in the above list. In South Australia the breeding season is in June and July, and six appears to be about an average litter.

It is a thoroughly useful little animal, and there would be considerably less havoc wrought by insect pests in Australia were the small members of the Genus *Sminthopsis* not preyed upon by domestic cats.

The rather smaller and paler form of the Fat-tailed Pouched Mouse which is found about Killalpaninna has been distinguished by Oldfield Thomas (1902) as *Sminthopsis crassicaudata centralis*. The tail in this variety is relatively long, as in the examples measured by Sir Baldwin Spencer. The dimensions are as follows:—Head and body, 79; tail, 63; hind foot, 15.5; ear, 22.

(2) Finke River Pouched Mouse.

SMINTHOPSIS LARAPINTA (Spencer, 1896).

Resembling *S. crassicaudata*, but with a longer tail, and proportionately longer hind feet.

Size small, form light and delicate. Fur very soft and fine, moderately long, composed almost entirely of under-fur with a few long dark hairs. General colour mouse grey, suffused on the dorsal surface with rufous. The sides, under surface of the head and body, and upper surface of the manus and pes are white. The face is marked by a darker stripe passing through the region of the eye. Ears large, laid forward they reach considerably beyond the eye. Palms naked, granular. The posterior external pad is V-shaped with the apex pointing forwards. The ulnar carpal vibrissae are well-developed. Soles granular anteriorly and in the median part; four pads present, three large ones at the bases of the toes, and a small one at the base of the hallux. Tail much longer than the head and body;

very stout in its basal part, and strongly incrassated, tapering to a long thin end. Strongly scaled, with, at the proximal end, short hairs which do not hide the scales. Towards the tip the hairs are longer and more numerous.

DIMENSIONS.

	♂	♂	♂
Head and body	88	85	95
Tail	105	95	111
Hind foot	18.2	17.5	18
Ear.....	14	15	16

The above description is taken from the account of Sir Baldwin Spencer, who obtained the animal at Charlotte Waters. It inhabits the stony tablelands, and is said to live in burrows.

(3) Hairy-footed Pouched Mouse.

SMINTHOPSIS HIRTIPES (Thomas, 1898).

Size medium. Colour more or less fawn above, white below, the hairs slate-coloured at the base. Ears very large, laid forward they reach some way beyond the front of the eye. Tail long, slightly incrassated for its basal half, dull whitish throughout.

Manus with a large trefoil-shaped elevation occupying the whole of the palm, the elevation being covered all over with fine silvery hairs, without any of the normal pads. Under surface of digits naked and very finely granulated. Pes with uniformly hairy sole, the middle line of the digits being alone naked. As in the manus there is a single large elevation, clothed with hair, and devoid of separate pads. All the hairs of the foot, above as well as below, are longer than usual, and especially those along the outer surface, where they form a distinct silvery fringe from the ankle to the tip of the fifth digit. Skull stouter and larger than that of *S. crassicaudata*, and with larger bullae.

DIMENSIONS.

Head and body	76
Tail.....	81
Hind foot	19
Ear	22.5

DIMENSIONS OF SKULL.

Basal length	24
Breadth	15.3
Interorbital	5.1
Palate. length	13.2
M ¹ - M ³	4.7

The above description is taken from Oldfield Thomas's account of the original male specimen obtained at Station Point, Charlotte Waters. It is obviously a form adapted to a desert habitat, the type of foot even foreshadowing the specialised condition of the feet of the desert-living Genus *Antechinomys*.

(4) **Slender-tailed Pouched Mouse.**

SMINTHOPSIS MURINA (Waterhouse, 1837).

In general form this little animal is slender and delicate. It is remarkably mouse-like, looking at first sight like a finely built, sharp-nosed monodelphian mouse. The general colour also is very like that of the common house mouse.

Fur fine and soft, mostly consisting of under-fur; the longest hairs of the back measuring 10mm. The face is lighter than the general body colour. A faint darker patch immediately around the eye. The dorsal surface of the body and crown of the head grizzled mouse-coloured, in some specimens rather warmer brown towards the middle line of the back. Chin, throat, under surface of the body and inner side of the limbs greyish; the hairs being smoky grey at the base and white at the tips. Manus and pes almost pure white. The tail is long, and though it is not incrassated, its diameter 10mm. from the base is greater than it is at the base itself; it is finely scaled and uniformly clothed with short pale brown hairs.

The ears are long, laid forwards they reach the middle of the eye, but the length is subject to considerable variation. The back of the ear is naked, save for a tuft of hair springing from the base; uniform brownish flesh-coloured. Within they are pubescent with pale-brown hairs, which are short and very fine. Processus antiheliciis is folded. The rhinarium is dark flesh-coloured, naked, finely granular, and cleft in the middle line. The eye is small and black; the eyelashes are fine and coloured light-brown.

All facial vibrissae are well-developed. The mystacial bristles are pale in colour, and the longest measures 21mm. The ulnar carpal setae are white and rather short, the longest measuring 9mm.

The manus with naked granular palms, and typical pads as in *S. crassicaudata*. The digital formula is $3 > 4 > 2 > 5 > 1$.

The pes with soles which are hairy at the sides and under the heel. The pads are granular. There are three interdigital pads as in *S. crassicaudata*, but in addition there is a small pad at the base of the first digit (hallucal pad). (See Figure 73). The digital formula. is $4 > 3 > 5 > 2 > 1$.

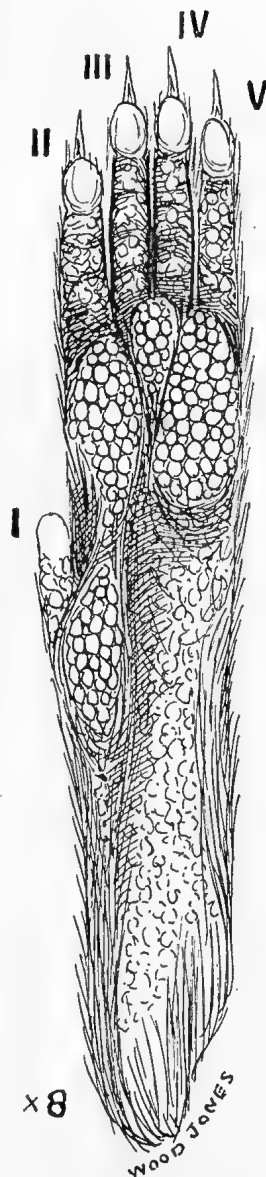


FIGURE 73.—Left pes of *Sminthopsis murina*. Eight times natural size. Showing the pad at the base of digit I., which is absent in *S. crassicaudata* (see Figure 71).

The hallux is small and clawless. The pouch is well-developed. The nipples, as a rule, 8 in number. Skull practically identical with that of *S. crassicaudata*.

DIMENSIONS.

	Adelaide.			Brit. Mus.	
	♂	♀	♀	♀	♂
Head and body	95	90	85	84	81
Tail	85	75	72	83	90
Hind foot	15	16	14	16	16
Ear	14	16	15	11.5	13

DIMENSIONS OF SKULL.

	Brit. Mus.
Basal length	25
Breadth	15.3
Nasals, length	9.8
Interorbital	5.4
Palate, length	13.9
M ¹ - M ³	4.7

Although in books this little animal passes uniformly under the name of "Common" Pouched Mouse, it is by no means a common species. In South Australia it is not nearly so frequently met with as is *S. crassicaudata*. Like the Fat-tailed Pouched Mouse, it is a very variable animal in its general size and proportions ; and, as will be seen from the measurements given above, the form of the species which lives about Adelaide is rather remarkable for the shortness of its tail, although it is a somewhat large representative of its species. It is an animal which is very rarely seen except when it has fallen the victim to a cat, and but little is known of its life history. Its range is evidently a wide one ; it extends to the Centre, but even there, is nothing like so common as is *S. crassicaudata*.

The form *Sminthopsis murina constricta* (Spencer, 1896), which is unfortunately represented only by a single specimen from Oodnadatta, is a type which is in some ways intermediate between *S. murina* and *S. crassicaudata*. It possesses a tail which is as long as that of *S. murina*, but it is incrassated as is that of *S. crassicaudata*.

DIMENSIONS OF THE TYPE ♀ SPECIMEN.

Head and body	71
Tail	80
Hind foot	15.5
Ear	12.5

GENUS 5. ANTECHINOMYS (Krefft, 1866).

Within this Genus are contained the beautiful little Jerboa Pouched Mice of the Centre. They are a specialised saltatory modification of a *Sminthopsis*-like form, just as the monodelphian Jerboa Mice of the Centre (*Notomys*) are a saltatory modification of a more typical form of mouse. In size they are small ; extremely elegant and slender in build, and generally showing a maximum of characters adapted to highly developing jumping habit.

The ears are very large. The tail is very long, and tufted towards its tip. The limbs greatly elongated. The hallux is entirely absent. Soles and palms granular. Pads largely fused into simpler elevations. Soles hairy in the greater part of their length.

Dentition I. $\frac{4-4}{3-3}$.
 C. $\frac{1-1}{1-1}$. PM. $\frac{3-3}{3-3}$.
 M. $\frac{4-4}{4-4}$. The bullae at the base of the skull are very large. The animals are terrestrial and saltatory in habit, and insectivorous in diet. Probably only one species is found in South Australia.



FIGURE 74.—*Antechinomys spenceri*. Two-thirds natural size; from a male South Australian specimen.

South Australian Jerboa Pouched Mouse.

ANTECHINOMYS SPENCERI (Thomas, 1906).

In general appearance and size remarkably like the desert-living jumping mice of the Interior. Form slender and graceful, with an almost exaggerated specialisation to a saltatory habit. (See Figure 74).

Fur very long and soft, almost wholly composed of under-fur. General colour a grizzled fawn grey. Head grizzled. Hairs dark smoky grey at the base and light at the tips. Immediately around the eye are slightly darker hairs succeeded by paler areas above, below, and in front of the eye. Mid line of the face and crown of the head darker. Occipital region and mid line of dorsal surface darker than the general body colour. The dark crown of the head in contrast to the paler face and snout region is a conspicuous feature. Hairs of the back 14mm. long, very fine and soft, smoky grey at the base, pale at the tips. Chin and throat white, the hairs being white to their roots. Chest and ventral surface white, the hairs being smoky at their roots. Limbs clothed with body hairs only to the upper third of the forearm and middle of the leg (tibia). The rest of the long delicate limbs pubescent with short fine white hairs. Tail much longer than the head and body, clothed with short closely adpressed fawn coloured hairs in rather more than its basal half; in the terminal half the hairs become slightly longer, and in the terminal third constitute a rather prominent pencil of dark-brown hairs, the individual hairs being 10mm. in length. The ears are enormous, folded forwards

they completely cover the eye. (See Figure 75). In colour they are pale pinkish fawn. The dorsal surface is pubescent in the upper part (above the line of folding), almost naked below. The inner surface and the margins beset with fine fawn-

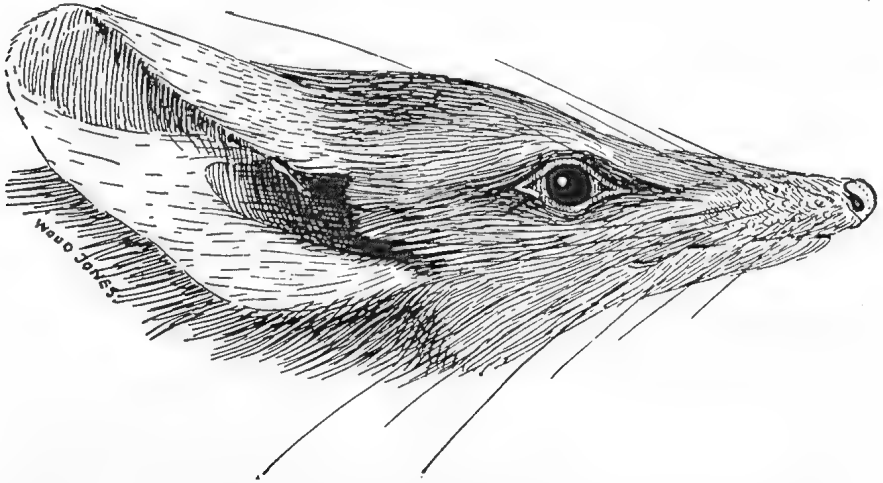


FIGURE 75.—*Antechinomys spenceri*. Characters of the head and face, from a male South Australian specimen. Twice natural size.

coloured hairs; the deeper portions of the concha naked. Processus antihelictis thin and leaf-like. Rhinarium brownish flesh-coloured, naked and granular: completely divided by a median cleft in its whole extent. The eye is black, fringed by a row of fine dark eyelashes both above and below. The facial vibrissae are



FIGURE 76.—*Antechinomys spenceri*. Fore limb to show the great development of the ulnar carpal vibrissae. Twice natural size.

well-developed, the mystacial bristles being 23mm. in length. They are dark at the base, and pale towards the tip. The supraorbital set represented by a single vibrissa only. The ulnar carpal set shows a most remarkable development. The tuft consists of 3 or 4 white hairs, one of which reaches the extraordinary length of 30mm. (See Figure 76). The manus has a naked and granular palm with three crowded interdigital pads. The 1st interdigital pad is fused with the thenar pad. The hypothelar pad is large. The digital formula is $3 > 4 >$

$2 > 5 > 1$. The pes is very highly specialised. The middle line of the sole is darker than the margins; it is hairy in its whole extent, there being a hair vortex just anterior to the posterior third. The only naked portion of the sole consists of one elevation, granular in its fore part, hairy behind. This single elevation represents the fused interdigital pads. The hallux is entirely absent.

The digital formula is $4 > 3 > 5 > 2$. (See Figure 77). The pouch is entirely absent. The nipples are 6 in number, arranged in a circle. The skull is light and delicate. It is broad in general outline. The nasals are not expanded at their posterior ends. The bullae are extremely large; and mastoid inflation is also well marked.

DIMENSIONS.

	S.A.	S.A.	Spencer. Horn Expedition.				
	♂	♀	♀	♂	♀	♂	♂
Head and body	110	110	100	95	95	87	82
Tail	144	120	136	138	136	129	116
Hind foot	33	30	32	33	31	28.5	29
Ear.....	22	21	21	19	20	23	22

DIMENSIONS OF SKULL.

Basal length	26.7
Breadth	15.7
Interorbital	5.6
Palate, length	15.3

Although first described in 1866 *Antechinomys* remains an extremely rare animal, and specimens are very difficult to obtain. It is a creature of the more arid regions, where sand ridges and tussocks of stunted vegetation constitute the typical environment. It furnishes a good example of the scarcity in numbers of carnivorous as compared with herbivorous animals; for though utterly different in every fundamental feature from the monodelphian Jerboa Mice (*Notomys*) of the Centre it is in general build and habit remarkably like these creatures; and yet *Antechinomys* is an animal of the greatest rarity, while the vegetarian mice exist in vast numbers in the same environment.

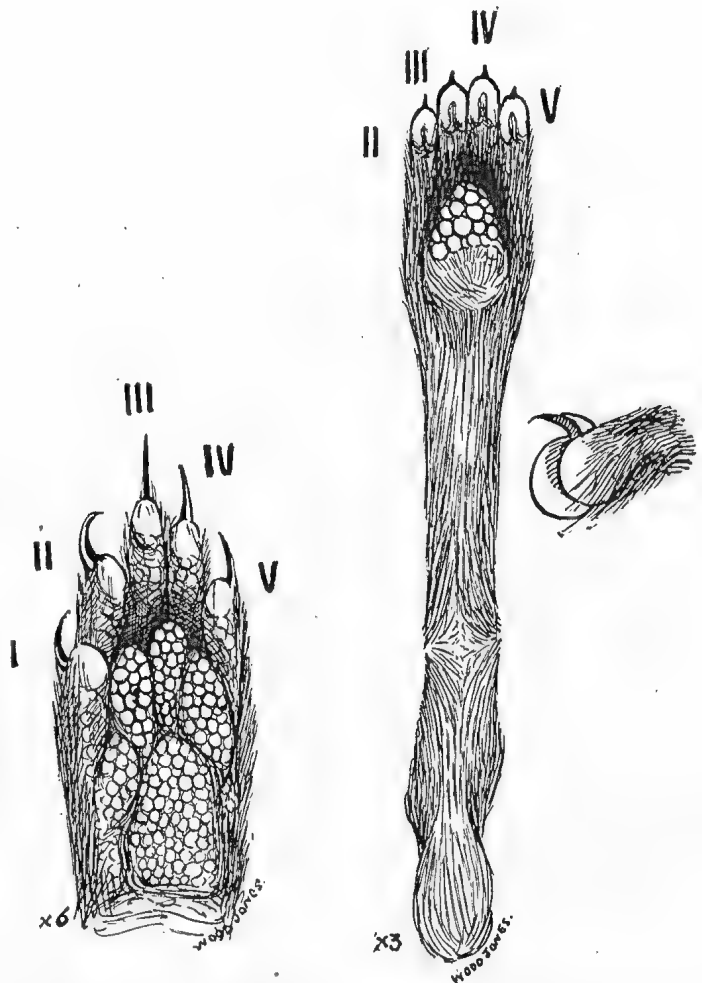


FIGURE 77.—*Antechinomys spenceri*. Left manus and pes. Manus six times, pes three times natural size.

It is a remarkably specialised saltatory animal which spends the hottest hours of the day in burrows in the sandhills. Though extremely rare, its range is probably a wide one. The specimens taken by the Horn Expedition were from the Missionary Plains, beyond the northern limits of this State, but subsequent examples have been procured from Charlotte Waters, and it is practically certain that it exists far into South Australia in the enormous tract of country where sand ridges, stony table lands and stunted saltbush provide it with its elected habitat. The South Australian form was named *Antechinomys spenceri* by Oldfield Thomas, after Sir Baldwin Spencer, from specimens collected at Charlotte Waters. The old-established species known as *A. laniger*, which is slightly smaller, and has shorter ears and far smaller bullae, does not appear to have been found in this State.

FAMILY III.—**THYLACINIDAE.**

This Family contains but a single Genus—*Thylacinus* (Temminck, 1825)—which is represented only by a single living species. Known variously as “wolf,” “tiger,” and “hyaena” this animal (*Thylacinus cynocephalus*) is in general build rather dog-like. (See Figure 78). It has ceased to be an inhabitant of continental Australia, but at one time it flourished in this State. Its remains are present among the bone deposits of the Bukalowie caves near Carrieton. At the present day it is confined to Tasmania, and it lingers now only in a few of the more inaccessible and mountainous parts of the country.

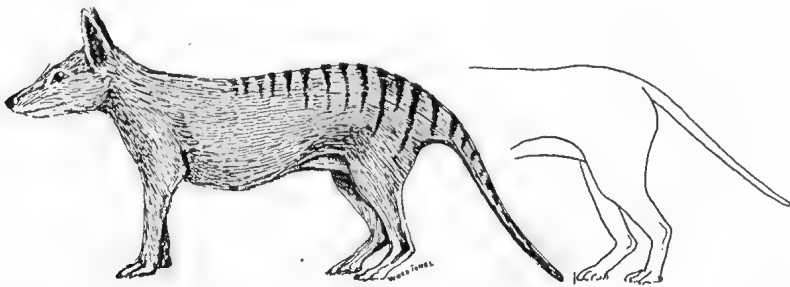


FIGURE 78.—*Thylacinus cynocephalus*. General appearance of the animal about one-twentieth natural size. The outline depicts the hindquarters of a dog of comparable build, and is inserted to show the difference in the manner in which the hind end tapers to the tail in the two animals.

FAMILY IV.—**MYRMECOBIDAE.**

The Family contains only a single Genus, in which is included but one described species.

The molar teeth exhibit characters which are probably degenerate rather than primitive; and they exceed $\frac{4-4}{4-4}$ in number.

The tongue is elongated, cylindrical, and extensible. The palate is complete, and unusually prolonged. The pouch is entirely absent.

GENUS.—**MYRMECOBIUS** (Waterhouse, 1836).

The Genus is a remarkable one, distinguished from all other didelphian Genera by several very striking features. The snout is long and tapering; the rhinarium naked. The ears are simple. The tail is long and clothed with harsh brush hairs.

The manus has 5 digits, the pes only 4; all digits armed with strong claws. The pads of sole and palm are reduced and punctate. The skull is broad and rounded; the nasals expanded in their posterior portion. The bullae are large. The angle of the lower jaw is but little inflected. Dentition—I. $\frac{4-4}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{3-3}{3-3}$, M. $\frac{5-5}{6-6}$. Terrestrial in habit, and insectivorous in diet.

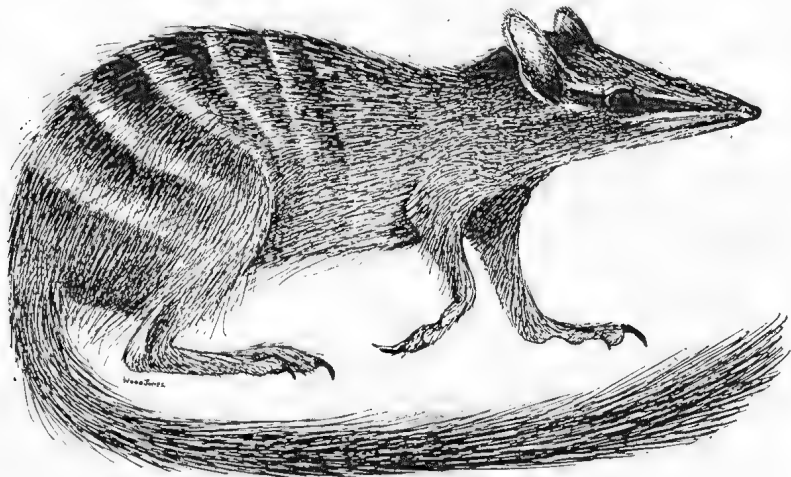


FIGURE 79.—*Myrmecobius fasciatus*. A female South Australian specimen. Half natural size.

Banded Ant-eater. Marsupial Ant-eater. White-banded Bandicoot.

MYRMECOBIUS FASCIATUS (Waterhouse, 1836).

These names are all merely book designations, for the animal appears never to have been sufficiently common or conspicuous to have earned a popular or familiar name. To the aborigines, however, it is known as the Numbat, and this name will be adopted here.

The Numbat is an animal which possesses the distinction of being so peculiar a creature that it cannot possibly be mistaken for any other species. It must be emphasised at the outset, however, that the South Australian form differs very markedly from the Western Australian type of the species. It is the Western form which was described and named by Waterhouse, and the description of the species in all works dealing with the Australian fauna applies to that type. Here the description is of a typical South Australian example, which I propose to describe in a scientific journal under the name *Myrmecobius rufus*.

The animal is about the size of a rat, and in form it is generally likened to a squirrel, but the simile is extremely unapt. (See Figure 79). Its figure differs from that of most small mammals in the remarkable breadth and flatness of the hinder part of its body; the region of the loin, instead of being arched in typical mammalian fashion, is flattened much as it is in the lizards. This is the most characteristic feature of the general form of the animal, and it quite destroys any likeness that the Numbat might otherwise have to a squirrel. The head is also remarkably flat. The coat is harsh and coarse, the hairs of the dorsal surface

being especially hispid, each hair having the character of a fine, sharply pointed bristle. The general colour is bright rust red, becoming increasingly dark towards the hind end of the body. The region of the loins is coloured a fine bright brown, but nowhere does it become black. Upon the crown of the head and the fore part of the back is a slight admixture of creamy white hairs, some of which are white to their roots, and some only white at the tips. Towards the hinder (darker) extremity of the body the white tipped hairs become more regularly disposed, and constitute six or seven creamy white bars adorning the dorsal surface of the

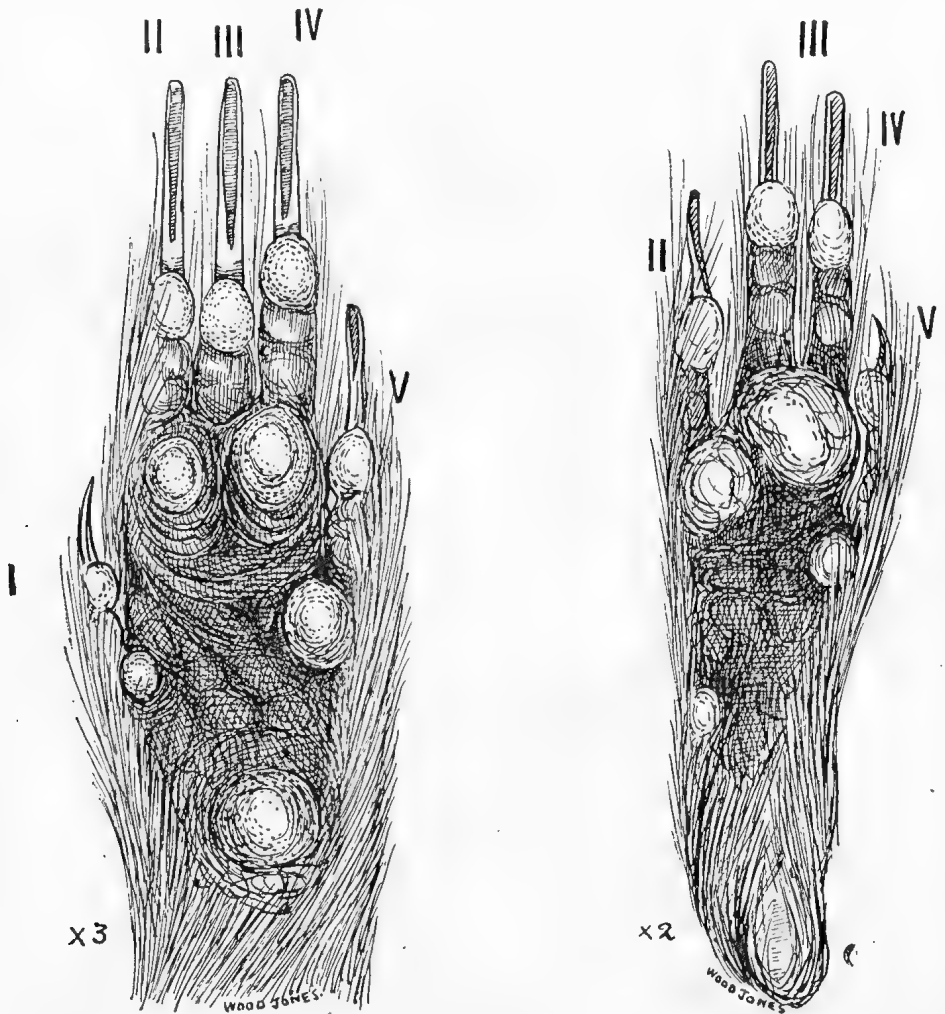


FIGURE 80.—*Myrmecobius fasciatus*. Left manus and pes of a Western Australian specimen. Manus three times, pes twice natural size.

body and loins. Of these pale bands the three posterior ones are complete and conspicuous, the three or four anterior ones are narrow and often interrupted in the mid dorsal line. It is not uncommon for the median ends of the bands to overlap, so that the pattern is not the same upon the two sides of the body. In front of the defined bands there are often traces of others, and in some specimens there are suggestions of as many as nine bars, the anterior ones being only just discernible. Upon the chin, throat, ventral surface of the body and inner aspect

of the limbs the hair is shorter and uniformly sandy-coloured. The muzzle is darker than the general colour of the head, and is clothed with extremely short hairs. A dark cheek stripe runs from the muzzle to the eye, thence to the ear; above and below this stripe there are paler areas, the lower pale stripe being better marked than the upper one. The tail is long and uniformly clothed with stiff, harsh hairs, which stand out boldly and constitute a brush. The individual hairs are nearly 30mm. in length. In colour the tail is a uniform grizzle of rust red and dark brown, the hairs being dark at the base and paler at the tips. The ears are rather small, considerably thicker than those of the *Didelphia* already described, and apparently incapable of being folded. They are clothed upon both surfaces with very short hairs, bright rust-coloured without, paler within. The processus antihelicis is small and thick. The rhinarium is naked, granular, dark-brown in colour and cleft in the middle line. The nostrils are cleft laterally. The eye is dark-brown, the pupil circular, the eyelashes are sparse and black. Vibrissae are not well-developed, the mystacial set being singularly reduced. The genal tuft is most marked and consists of three or four black bristles some 15mm. long. Only two supraorbitals are present. The ulnar carpal set is unrepresented. The manus has 5 digits. The palms are naked, dark in colour, and punctate in texture. The pads consist of coarse elevations, of which there are two large interdigitals in the fore part of the palm, two smaller ones at the bases of the 1st and 5th digits, and a large one far back upon the ulnar side. The digital formula is $4 > 2 > 3 > 5 > 1$. Apical pads are well-marked; the claws are long and curved; the digits clothed with coarse hair to their tips. The pes has 4 digits. The sole is naked, save for the overlap of coarse hairs from the sides. The pads are reduced, there being two large interdigitals in the fore part of the sole, a small one at the base of the 5th

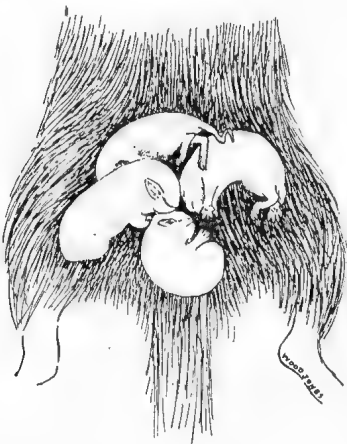


FIGURE 81.—The four embryos of *Myrmecobius fasciatus* adhering to the mother's nipples. From a Western Australian specimen. Half natural size.



FIGURE 82.—The pouch area and nipples of *Myrmecobius fasciatus*. The embryos have been removed from the nipples. Same specimen as illustrated in Figure 81. Half natural size.

digit, and another small one marking the site of the absent 1st digit. The digital formula is $3 > 4 > 2 > 5$; The hallux is not developed. (See Figure 80). The pouch is entirely absent, its site being marked by specialised crimped hairs, finer

in texture than the general body hairs. The nipples are four in number, arranged at the four corners of a square. (See Figure 82). The essential characters of the skull are shown in Figures 37, 83, and 84.

	DIMENSIONS.	South Australia.
		♂
Head and body		175
Tail		135
Hind foot		43
Ear		20

DIMENSIONS OF SKULL.

	Western Australia.	
	♂	♀
Basal length	50	45
Breadth	29	25
Palate, length	35	32
Interorbital	15	14
Nasals, length	20	17

The Numbat was probably never a very abundant animal, but its distribution was comparatively wide. Only twenty years ago it was met with along the scrub lands of the Murray, and earlier than that it existed quite near to Adelaide. Enquiries as to its present existence have produced negative replies from all those parts of the State in which there are schools, and the circulation of its picture and description to more remote districts have proved equally unavailing. The aboriginals who are attracted to civilisation, as it is represented by the East-West railway, know the animal, but so far have failed to supply any evidence as to its actual existence at the present time. If the Numbat still exists in South Australia it is probably towards the Western Australian border, and here it is probably the Western Australian form. The characteristic South Australian type has probably gone for ever. Extremely little of the South Australian material was preserved when it was obtainable ; and now we know it only from the most meagre remains. The Western Australian animal is now excessively rare, and it is probable that before many years are passed it will follow its South Australian neighbour into extinction. The extermination of the Numbat is a tragedy in which man has probably played very little conscious part ; it is no tale of ruthless slaughter for gain, such as is being rehearsed to-day in regard to the Australian fur-bearing animals, nor is it a case of determined persecution as is the case with the Tasmanian Devil. *Myrmecobius* is an animal which is probably phylogenetically senile, which has become highly specialised in function and degenerate in some details of structure. Added to this is the fact that its home is invariably made in the hollow of a fallen tree or a rotting log. Accidental bush fires and the intentional burning off of country seem to have found the Numbat an easy victim, and they have exterminated it as they are exterminating other small terrestrial Marsupials. There is no escape from a bush fire for the Numbat. It does not excavate deep burrows, it does not climb, it is not fleet of foot—as its log home burns, it perishes.

Of its habits we know extremely little, and very few white men appear to have made observations upon the living animal. The original account by Gilbert, in Gould's great work, contains obvious inaccuracies ; and I know of no records of

the animal having been kept in captivity. It is surely a tragedy that this most interesting animal has probably passed out of existence in our State, and is rapidly repeating the process in a neighbouring one without any proper study having been made of it, and without any representative collection having been made of its remains. It will not be long before *Myrmecobius* will be as extinct as those Mesozoic Marsupials of the English Jurassic beds of which it has been said to be "actually an unmodified survivor." It is said to be absolutely inoffensive, to make no attempt to bite, and to utter a low grunt when handled. The breeding season in Western Australia is in June and July, and four young constitute the normal litter. There being no pouch, the young animals cling tightly to the mother's elongated nipples, and are dragged about back downwards in all her activities. (See Figure 81). The young are distinguished among the Marsupials by being remarkably unlike the parent animals. The Numbat is insectivorous and crepuscular.

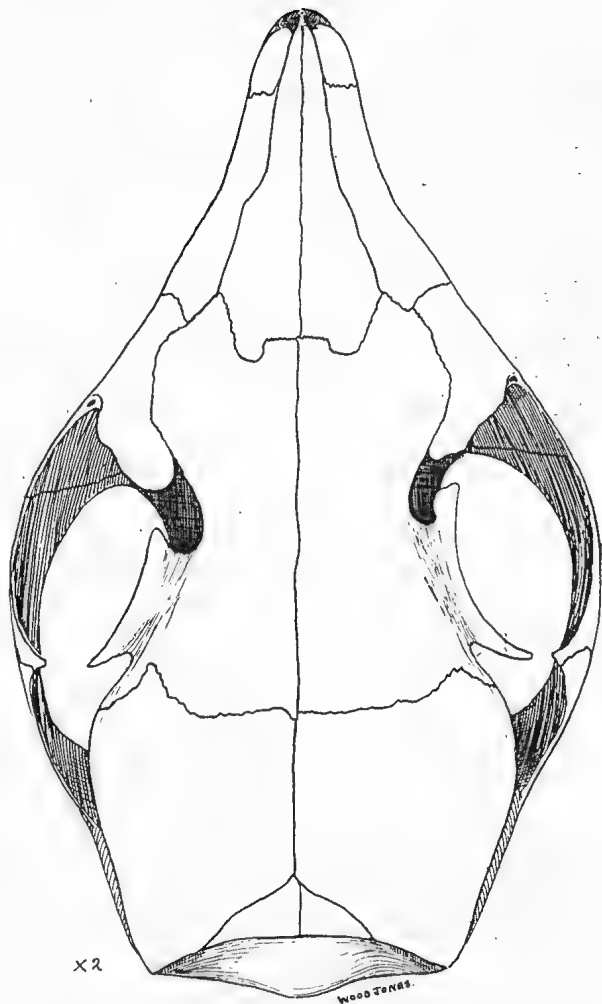


FIGURE 83.—Skull of *Myrmecobius fasciatus* seen from above. South Australian specimen. Twice natural size.

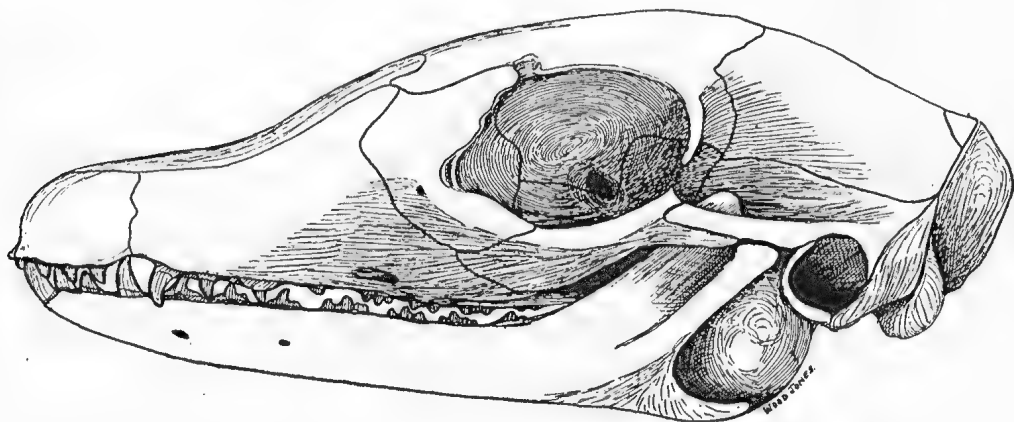


FIGURE 84.—Skull of *Myrmecobius fasciatus*. Side view of a South Australian specimen. Twice natural size.

FAMILY V.—NOTORYCTIDAE.

General appearance mole-like, the Family containing only a single remarkable Genus. Limbs short, stout, and strong, with 5 digits on both manus and pes. The eye is absent. There are no external ears. The cervical vertebrae are fused together.

GENUS.—NOTORYCTES (Stirling, 1891).

The Genus of "Marsupial Moles" is one of the most remarkably specialised products of the Didactylous section of the Didelphia. The dorsal aspect of the muzzle is covered with a hard shield. External ears are absent, there being only a small opening which is buried beneath the fur. Tail reduced to a rudiment, clothed by hard skin. Manus highly specialised for digging. Fur fine and silky. Pouch opening backwards

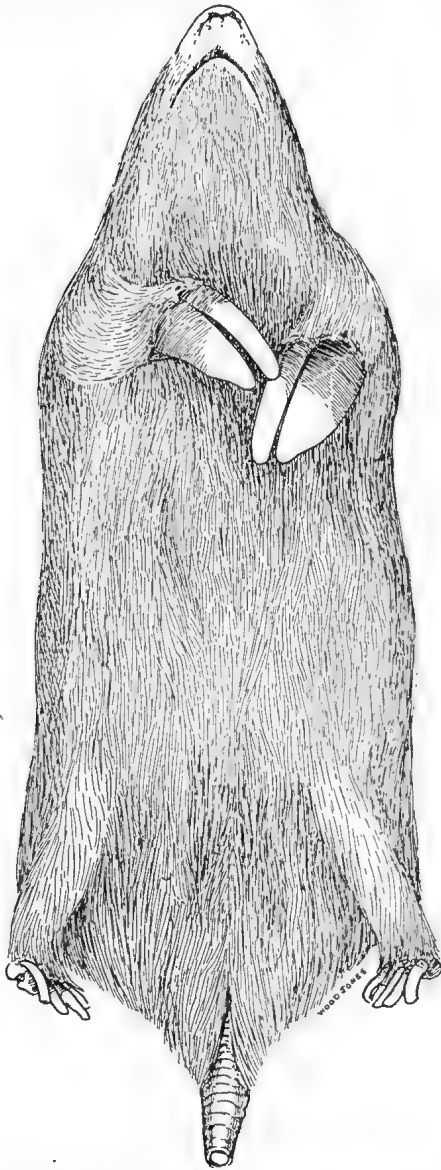


FIGURE 85.—*Notoryctes typhlops*. Ventral view of a female specimen from Ooldea. Natural size.

Marsupial Mole, or Pouched Mole.*NOTORYCTES TYPHLOPS* (Stirling, 1891).

This remarkable little animal which, discovered in 1888, was for some time one of the mysteries of the Australian fauna can now probably claim to be one of the best known Marsupials.

In general form it is strikingly like the African Golden Moles (*Chrysochloridae*). The fur is fine and silky, in colour varying from almost white to a rich red golden hue. When living, the coat has a remarkable sheen, which has been described as an iridescence, but which is very similar to the appearance of very fine plush. The long hairs of the back measure 13mm.; but the coat consists almost wholly of under-fur. There is a curious patch on the hinder part of the back, where the hair has the appearance of being matted. Fur clothes the short limbs as far as the wrist and ankle. The tail is reduced to a mere rudiment, 20mm. in length, and covered by a horny skin which is marked by a series of rings encircling its girth; the tip consists of a little horny knob. (See Figure 85). The whole rhinarium consists of a horny shield, which is divided into upper and lower portions by a

transverse groove. The nostrils are small and slit-like. Although marked by a conspicuous pigment spot in the embryo, the eye is completely degenerated in the adult. The external opening of the ear is marked as a little round hole buried beneath the fine silky hair of the side of the head. No sensory vibrissae are discernible anywhere upon the animal. The mouth is rather small, and is situated ventrally (see Figure 86). The manus and pes are remarkably modified. The sole and palm are thick and horny, without definite pads. The manus is curiously folded so that the small 1st and 2nd digits are opposed to the relatively enormous claws of the 3rd and 4th. The 5th digit is small and ends in a little horny boss rather than a claw.

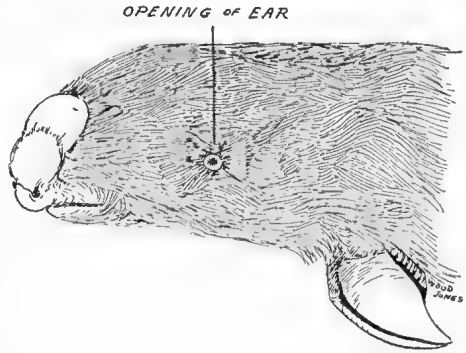


FIGURE 86.—Head of *Notoryctes typhlops*. The hair has been parted in order to show the external opening of the ear, which is normally buried beneath the fur. Natural size.

In the pes the 2nd, 3rd, and 4th digits bear claws; the 1st has a short horny point and the 5th is a rudiment. (See Figure 87). The pouch is well-developed, extending some distance forwards in front of its mouth; the nipples are two in number. The skull is light and delicate and of very peculiar shape. (See Figure 88). The full detention is—I. $\frac{4-4}{3-3}$, C. $\frac{1-1}{1-1}$, P.M. $\frac{2-2}{3-3}$, M. $\frac{4-4}{4-4}$; but irregularities in the number of teeth are very common.

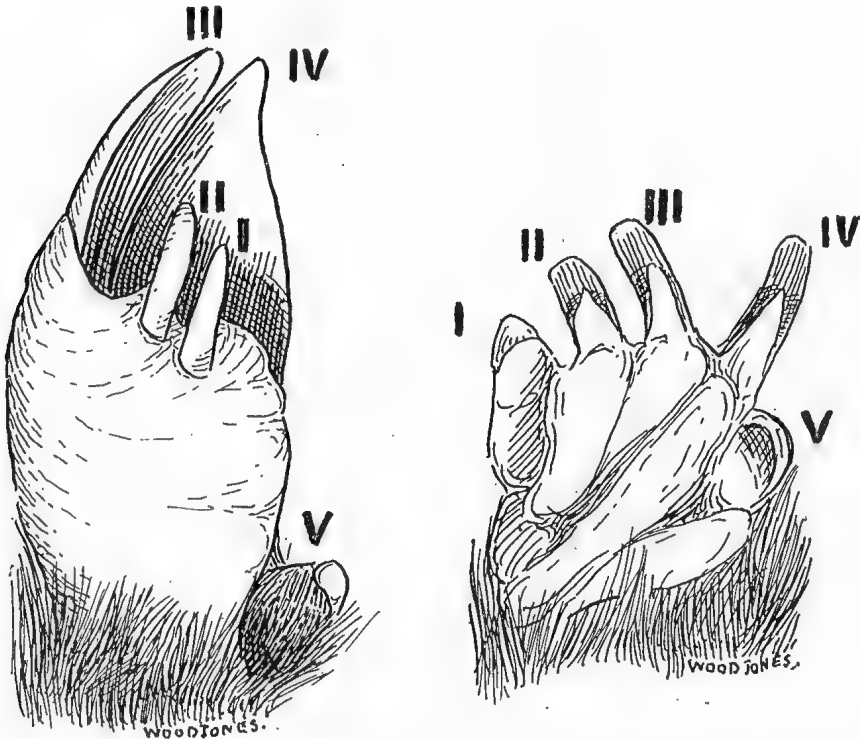


FIGURE 87.—Left manus and pes of *Notoryctes typhlops*. Three times natural size.

Dimensions of an average male South Australian specimen :—Head and body, 145; tail, 20; hind foot, 10.

Notoryctes is an inhabitant of the sandy and more arid parts of the country, and, owing to the nature of the soil in which it lives, is apparently not so completely a subterranean animal as are the true moles. The burrows which it makes in search of food are not permanent like the tunnels which are left by the European mole, and a portion of its time seems to be spent in furrowing the surface sand. It is, however, probable that it constructs deep permanent burrows in which the female lives and produces her young.

The Marsuipal mole not only resembles the monodelphian moles in its burrowing habits and its anatomical adaptations; it also resembles them in certain physiological traits. It may be said to be like the moles in its feverish restlessness. It evinces the most remarkable nervous activity. It makes endless tours around the confines of its cage, each peregrination being undertaken with characteristic energy and haste. It will search with feverish activity in each corner of its box, and regularly in each of the four corners turn a complete somersault in its enterprises. Suddenly it will discover something edible; the meal is accomplished with a maximum of speed; the performance is repeated and, in the case of a captive

specimen I have observed, a handful of earthworms will be noisily accounted for in a remarkably short time. The meal having been ingested at top speed, the animal will again start upon its rapid tour; but it has proceeded maybe no more than a foot or two when, as suddenly as it awoke to activity, it is fast asleep. Even its sleep seems hurried. It breathes rapidly. It awakes with a start and is off again. It does not evince fear, nor resent handling, in the least, and when held in the hand will take a considerable quantity of milk at a great pace, and then on a sudden fall asleep again. In all its activities it carries its extraordinary stump of a tail erect in a manner singularly reminiscent of its lizard companion of the Centre—*Nephhrurus asper*. Its gait is a rapid shuffling, the movements of its body strangely fluid and sinuous, so that when held lightly

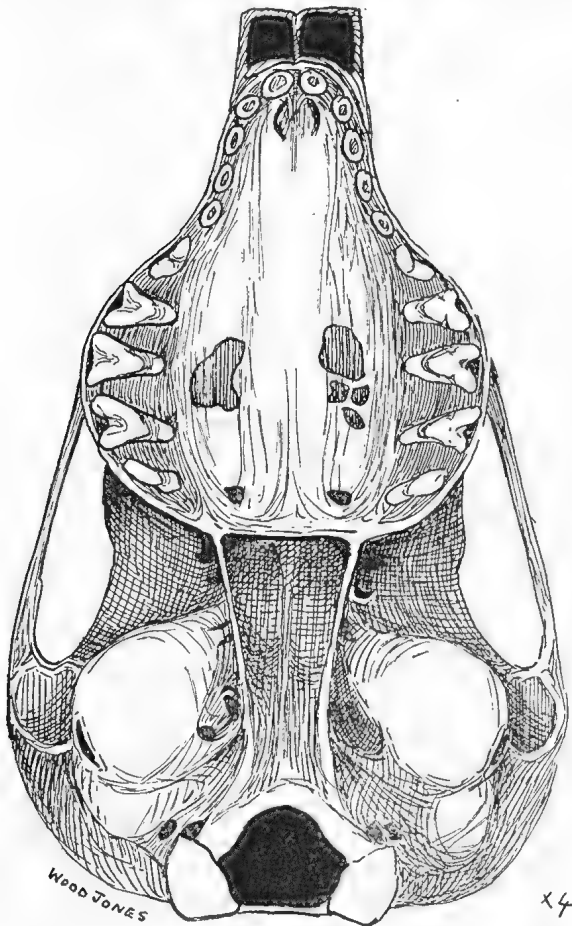


FIGURE 88.—Basal view of the skull and upper teeth of *Notoryctes typhlops*. Four times natural size.

in the hand it seems almost to flow between the fingers. It is said that when moving on the surface of the ground the tail is "adpressed and used as a fulcrum"; but this is an observation I am unable to corroborate. Nor am I in agreement with those who suppose that "fear has a good deal to do with their dying so quickly in captivity." It is true that their life seems to be carried on at such a high pitch that they appear as "very nervous little animals"; but I suspect that their active metabolism comes to an end rather through lack of food than from fright. Apparently they need an extraordinary amount of food when active; but possibly when inactive they can sustain prolonged fasts. They seem to be animals which live either at fever pitch or to remain almost wholly quiescent as season and circumstance demand. Of its breeding habits nothing is known, and the only embryo that I have succeeded in obtaining was the solitary occupant of the pouch.

Notoryctes has a far wider distribution than was imagined a few years ago. The original specimens were procured beyond the northern boundaries of South Australia; and in 1896 Spencer gave its range as extending "as far south as Charlotte Waters," just beyond the northern limits of this State. Since then it has been found in Western Australia, where it is represented by a distinct form named *Notoryctes caurinus* (Thomas), and in various parts of South Australia, where the typical sand ridge country with mulga and stunted saltbush provides a suitable habitat.

When the Transcontinental Railway from Perth to Port Augusta was under construction a most regrettable waste of scientific information was permitted. It is greatly to be hoped that a similar sacrifice of scientific interests will not be repeated when the route of the North-South Railway is constructed. *Notoryctes* was met with at several points during the laying of the railway line, but most of the material was wasted. It has remained for Mr. A. G. Bolam, of Ooldea, to preserve such specimens as came into his hands. To this gentleman South Australia is indebted for preservation of specimens, acquirement of knowledge, and the keeping of records of the native fauna and of the native tribes made known, and about to be exterminated, by the passage of the railway.

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